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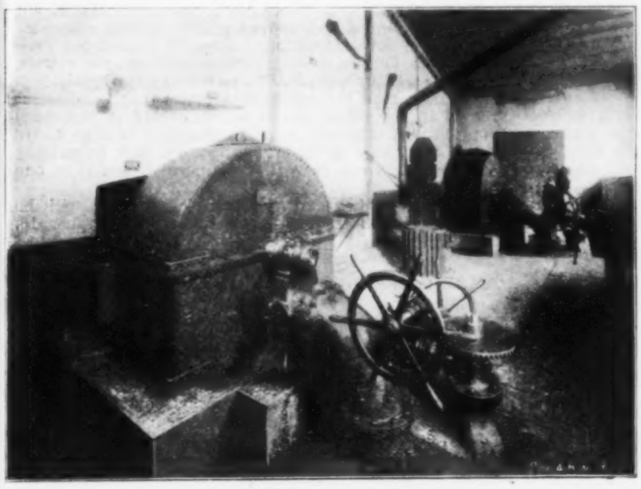
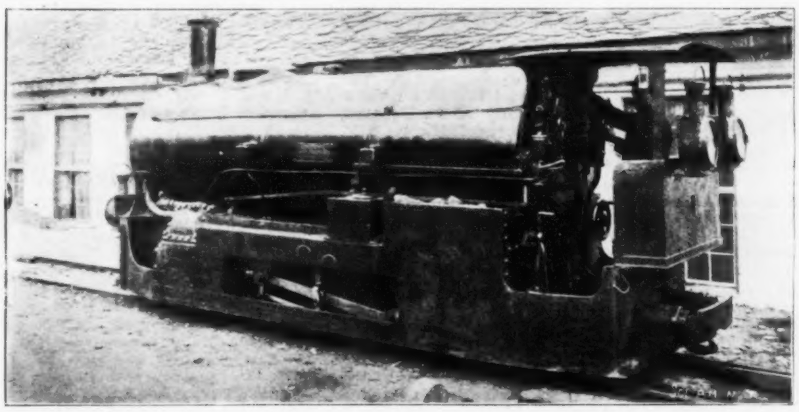


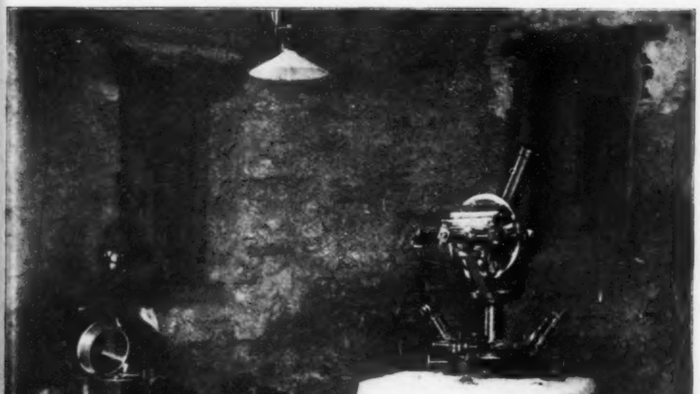
ONE OF THE 300 H. P. TURBINES FOR DRIVING VENTILATING APPARATUS.

THE FLUME BY WHICH THE WATER IS CONVEYED TO THE TUNNEL.

BRANDT HYDRAULIC ROCK-DRILLS.



A STEAM TUNNEL-LOCOMOTIVE.



OBSERVATORY WITH INSTRUMENTS USED IN DETERMINING THE LINE OF THE TUNNEL.

CUT IN THE FIRST TUNNEL, 4,500 YARDS FROM THE ENTRANCE.

WORK ON THE SIMPLON TUNNEL.

THE WORK ON THE SIMPLON TUNNEL.

When first the idea was conceived of tunneling the Alps by way of the Simplon Pass, the railway was still in its infancy. France, in those early days, was particularly interested in carrying out the plan. But when Sardinia began the construction of the Mont Cenis tunnel France abandoned her own intention and furthered that of the other country. With the completion of the Mont Cenis tunnel in 1871 France's needs, for a certain time, were fully supplied. Frenchmen not only lost all interest in the previously-projected Simplon tunnel, but also did everything they could to frustrate any scheme to build a rival tunnel. When Germany and Italy agreed to bore through the Alps no anxiety was felt; for the St. Gothard route had been selected as the most desirable course. Although the Swiss would have welcomed any plan for tunneling the Simplon, and even formulated projects of their own, there was so plentiful a lack of funds that nothing could be done. Switzerland, financially interested in the St. Gothard tunnel as she was, could not single-handed carry out a still greater undertaking. Not until the Jura-Simplon Railway Company had been established was there any possibility of realizing the long-cherished idea, and not until then was any work systematically begun. All extravagant schemes were sternly rejected after careful consideration. Every effort was made to map out a plan of work which would result in the construction of a passage through the Alps that was to be at least equal to the engineering work on the St. Gothard and Mont Cenis tunnels. The new road was intended to divert from St. Gothard and Mont Cenis a portion of their traffic, besides opening up an entirely new and profitable line of communication with northern Italy. That the railway distance between northwestern Europe and Italy can be materially reduced by a direct route is evident from a glance on the map of Europe. The road from Paris to Milan through Mont Cenis is 1,058 kilometers (654 miles) in length; and by way of St. Gothard the distance is 1,068 kilometers (663 miles). The Simplon tunnel would reduce the distance to 979 kilometers (608 miles). If a passage were cut through the Jura the entire distance could even be reduced to 900 kilometers (569 miles). A hundred miles even in our time is no trifle.

But the shortening of the distance between Paris and Milan presupposed the possibility of tunneling deep in the mountains in order to overcome all heavy grades—a possibility which, it was feared at that time, could never become a reality. It is clear enough that it is easier to haul a load through an upward distance of 500 yards than through twice that distance. This is practically the advantage of the Simplon tunnel over St. Gothard and Mont Cenis. The highest point of the Simplon tunnel lies at an elevation of 705 meters (2,312 feet); that of St. Gothard, 1,154 meters (3,786 feet); and that of Mont Cenis, 1,294 meters (4,241 feet). The greater the elevation, the greater are the difficulties encountered. Particularly in winter-time the additional expense of maintaining a railway in the Alps is considerably increased; and these additional expenses in the case of the Simplon route would be considerably reduced. Indeed, there is probably no other spot in the Alps so favorably situated for the consummation of an engineering scheme of this character. The approaches to the St. Gothard tunnel, by reason of their great length, were well-nigh as costly as the tunnel itself. The approaches to the Simplon tunnel, on the other hand, will be more modest and will as a result be less expensive. On the north the tunnel starts at the level of the valley; on the south the road, after a few miles, terminates on the very border of the great plain of Lombardy. Two obstacles, however, confronted the engineers—the cost and the technical difficulties presented. The first estimates reached so dizzy a height—$18,000,000 to $20,000,000, it was thought, would be required—that the profitableness of the enterprise was seriously questioned. The most serious technical objection raised was the impossibility of human beings' working in the bowels of the earth at dangerously high temperatures. Even in carrying out the St. Gothard scheme, temperatures of 32 deg. C. (90 deg. F.) had been recorded; and the diseases of the laborers, almost epidemics in character, were directly ascribed to the high temperatures in the tunnel. It was believed that an attempt to bore through the Alps by way of the Simplon Pass would be frustrated by even greater temperatures and still more serious epidemics. A temperature of at least 40 deg. C. (104 deg. F.), it was claimed, would be recorded. It was at first proposed to carry the tunnel through the mountains in a zigzag course. But such a plan would not have solved the problem.

Critics of the Simplon enterprise were apparently unaware of the great strides that had been made in all branches of engineering since the construction of the other Alpine tunnels. It had been proved time and time again that by the use of modern rock-drilling machinery rapid progress could be made, with a consequent reduction of cost. Although the Mont Cenis tunnel was completed only after thirteen years, and the St. Gothard tunnel after seven and a half years, the Simplon engineers bound themselves to carry out the work which they had planned in the short period of five and one-half years. Compared with the St. Gothard enterprise, the cost would be reduced by 25 per cent. By the use of improved machinery the estimated cost was reduced from $20,000,000 to $10,900,000. The problem of lowering the tunnel temperature and providing suitable ventilation means was no less happily solved. Instead of building a single two-track tunnel, it was decided to construct two single-track tunnels separated from each other, the one, during the work upon the other, serving as a huge ventilating-tube. While the one tunnel in its various sections is completed as far as possible, the other tunnel remains merely a narrow gallery to be finished only when required. According to the contract this task must be accomplished in four years at a cost of $3,000,000. How materially this simple method of ventilating has improved the sanitary conditions in the quarries is shown by a comparison of the St. Gothard with the Arlberg tunnel, built by the firm to whom the Simplon enterprise has been intrusted. During the construction of the St. Gothard tunnel the quantity of air supplied to the laborers was 1½ to 2 cubic meters (530 to 706 cubic feet) per second. The men in the quarries of the Arlberg tunnel were at first supplied with 3 cubic meters and later with 6 cubic meters per second. The Simplon workmen are still more fortunate; for 2.5 cubic meters (883 cubic feet) of compressed air are supplied to them per second. Moreover, the use of sprayers, it was believed, would result in cooling and purifying the air, so that the temperature would be reduced to some 15 deg. C. (59 deg. F.). The ventilating apparatus has proved exceedingly efficient; for, although the temperature of the St. Gothard tunnel has been at times reached, no diseases have arisen which could be attributed to the heat in the tunnel. It should not be forgotten, however, that the laborers are treated with a consideration which has, unfortunately, been lacking in the carrying out of other enterprises. The tunnel exits consist of covered passageways through which the workmen pass into huge bathrooms. Here they wash themselves and change their clothes. Indeed, the provisions made for the welfare of the men are exemplary in their way.

Long before the actual work could be commenced obstacles were encountered, in overcoming which almost as much time was consumed as in carrying out the actual work. The diplomatic contracts between Switzerland and Italy required considerable time before they were drawn up and signed. In 1893 negotiations were concluded between the Jura-Simplon Railway Company and the engineering firm of Brandt, Brandau & Co.; but five years elapsed before the first blast of rock was fired.

Although the necessary appropriations were not immediately forthcoming, the company did not remain idle. Great preparations were necessary for the successful consummation of the project. Above all, it was necessary to provide the necessary power. On each mountain side about 2,000 horse power are available, which are used primarily for the purpose of driving the ventilating machinery and hydraulic apparatus, as well as for the operation of the machine tools in the workshops and for driving the electric light dynamos. In the north, water power is furnished by the Rhone; in the south, by the Diveria. By a flume 1½ meters (nearly 5 feet) in diameter the water is led many miles to the turbines by which the water power is converted into mechanical energy. Large repair shops were necessary, in which several hundred men are employed. And these shops serve only the purpose of manufacturing tools and rock-drills. That so vast an undertaking should necessitate the establishment of auxiliary shops and power plants is easily understood.

When finally on August 11, 1898, permission was given to begin work, all preparations had been made, so that no time was lost. Actual tunneling began on November 13, and from this day the period of five and a half years in which the tunnel must be completed must be dated. For each additional day required in excess of the stipulated time a forfeiture of five thousand francs ($1,000) will be imposed; on the other hand, if the contract be fulfilled before the stipulated time, a similar sum will be paid for each day within the period. It is, of course, understood that strikes are not to be included in the contracted time.

About half the tunnel is now completed; and if unforeseen difficulties are not encountered the work will probably be completed within the contracted time. At first, progress was slow, particularly on the south side, where the rock was exceedingly refractory. How arduous was the labor of boring through this rock is illustrated by a few examples. On the northern side the daily progress is about 6 meters (20 feet); on the southern side, 5 meters (16 feet). This daily advance is attained by three attacks—drilling, blasting, and removing the blasted material, each of which attacks requires from 6½ to 7 hours. On the northern side 7 or 8 drill holes are made for each blast; on the southern side, 11 to 12 drill holes are necessary. On the northern side the rock is drilled to a depth of about 2 meters (7 feet); on the southern side a depth of 1.2 meters (4 feet) has proved most effective. In order to blast one cubic meter (1.3 cubic yards of rock) 4 kilogrammes (9 pounds) of dynamite are required on the nothern side; at least 5 kilogrammes (11 pounds) are required for 1 cubic meter on the southern side. One can easily understand why the enormous quantity of 13,000 to 15,000 kilogrammes (28,600 to 33,000 pounds) of dynamite is used each month. The rock formation from the south to the north along the tunnel line consists of 6,330 meters (8,229 yards) of calcareous mica schist; 9,700 meters (12,610 yards) in which Teggialo lime, calcareous mica schist, mica schist and gneiss, Valle lime, stratified gneiss, crystalline schist and gneiss, and lime are found; and 3,700 meters (4,810 yards) of mica schist and gypsum rock on the Rhone. The entire tunnel length is 19,730 meters (25,649 yards).

In each tunnel quarry three Brandt hydraulic rock drills are used. The water pressure on the north side varies from 60 to 70 atmospheres, depending upon the nature of the rock; on the southern side the pressure varies from 90 to 100 atmospheres. On the northern side this pressure is raised to 13,200 to 15,400 pounds at the drills, and on the southern side to 19,800 to 22,000 pounds. Without these high-pressure machines the rapid progress made would be impossible.

The laborers are, for the most part, Italians, recruited from all parts of Italy, from Piedmont to Sicily. The stronger and more industrious north Italian is preferred to the others; for the southern men usually leave their work in the winter and return to their homes. But, despite this annual desertion during the cold weather, ten men are always ready to fill a vacancy. Applicants for work must apply to the superintendent each day in little groups. Many of the men journey to the Alps with their wives and children, and settle down when they have found employment. Thus is happens that on each side of the mountain whole villages have sprung up like mushrooms during a night. At the present time about two thousand men are employed on each side of the mountain. The laborers have all the virtues and all the vices of southern Europe. For the most part sober and industrious, they are, however, extremely excitable. Nevertheless, tavern brawls occur rarely, a circumstance which is perhaps due chiefly to the admirable police force which has been established. Much of the feeling against the Italians employed on the tunnel can be traced to the fact that the money earned is not spent in Switzerland, but is sent to Italy. Moreover, each laborer is considered something of a revolutionist in disguise, although most of the men have no real idea of what socialism and anarchy mean. It cannot be denied that the Italians employed are only too easily influenced by fiery speeches, and that they are ever ready blindly to follow their leaders without knowing whither. The most recent strike is a proof of this circumstance. In Brieg during one of the shifts the order was suddenly given to lay down all tools and stop work. Only a few knew the reason for this command; but all immediately obeyed. As a general rule, however, strikes are followed in a few days by a return of the laborers to their tasks under the old conditions.

Untrustworthy employés are nowhere acceptable, but here much must be endured which cannot otherwise be cured. Both sides must make allowances for each other's prejudices. Despite these interruptions work is fairly continuous. At no distant day the world will awaken to read the astonishing news that the longest tunnel in the world has been completed. A few more months will then elapse, and the period of nine hours which the fast express trains now consume in passing over their old course will be reduced to less than one hour.

Additional views of the Simplon tunnel will be found in the Scientific American for November 16, 1901.

AMERICAN AIR BRAKES ON RUSSIAN RAILROADS.

The continued growing demand for American railroad appliances throughout the world is little short of marvelous. This story of progress reads like a chapter from the Arabian Nights and the work of genii, but the plain facts are even more eloquent than any flights of the imagination. We have become a world power, as our rapidly increasing foreign exports show. And so great is the demand for American manufactures abroad that the ordinary machinery of commerce (in the shipment of goods to foreign countries) is insufficient to meet the wants of those who desire what the ingenuity and enterprise of American manufacturers provide in such perfection.

Unable to fill the large number of orders that pour in upon it from all quarters of the globe, the New York Air Brake Company has established a manufacturing plant in Russia, thereby reversing the declaration that "westward the course of empire takes its way"—for in this instance the course of empire trends eastward.

Ten miles from Moscow, the city of the Kremlin and the former capital of Russia, the advance guard of American industry and manufacture has obtained a foothold by ideally peaceful means. While in 1812 the invading forces of France under Napoleon were driven out of burning Moscow and perished by fire, sword and privation, the New York Air Brake Company is now welcomed with open arms and every facility afforded by the Russian government to enable American citizens to carry on their great enterprise successfully, says the New York Times.

A tract of land forty acres in extent on the Moscow-Kazan Railway is the home of the Russian branch of the New York Air Brake Company. The railroad tracks run right into the yards. Five buildings of brick and steel are already finished. Each is 200 feet long by 100 wide. The framework of the interior construction is of steel. There are glass roofs and all the latest modern appliances throughout the structures, which were fully completed about six months ago. The plant is now being equipped with the necessary tools and machinery from this country, and it is stated will be in operation in January, 1902. Pending the complete equipment of the works in Moscow and the ability to execute all European orders there, the Air Brake Company is shipping such orders from the manufactory in this country to the principal railways in Russia, Germany, Holland, Belgium, and Sweden and Norway.

The policy of establishing plants in foreign countries for the manufacture of such indispensable railroad appliances will no doubt be followed by other companies, now that the Air Brake Russian works have so successfully overcome the numerous difficulties in obtaining a footing in that country.

But the New York Air Brake need not go to Russia to increase its output. In this country it has more orders than it can attend to, and that the business grows rapidly cannot be doubted. The company's outlook for the coming year is most promising, and it is estimated that the company's business will more than double in volume that of 1901. Upward of fifteen important railroads have recently turned their business over to this company.

It seems scarcely fair to class New York Air Brake with other industrials. As is well known, it is the practice to largely capitalize many industrials. Some of them have stock running into and upward of a hundred million dollars, with several classes of securities, common, preferred, and bonds, whereas this company has only its common stock, of which there are but eight millions outstanding. It has no preferred stock and no bonds, and it owns its own plants in this country and Russia, free and clear from any indebtedness.

The company has not been without its vicissitudes since its incorporation under the laws of the State of New Jersey, in 1890. It was fought by the Westinghouse Company for many years on the ground of infringement of patents, but in 1897 the United States Supreme Court established the validity of its patents. From that time its business has steadily increased, until it is now selling to more than seventy different railway companies.

New York Air Brake stock, which was a few months ago quoted at $137 per share, sold this week on the New York Stock Exchange at 159¾. With the Russian plant in working order and the business here

continuing to increase in the same ratio as during recent years, the outlook for New York Air Brake is certainly very bright.

NICARAGUA OR PANAMA.*

By PHILIPPE BUNAU-VARILLA, former Engineer-in-Chief of the Panama Canal.

GENTLEMEN: It will be my effort to lay before you a series of facts officially or scientifically established and to show at their clear light the real aspect of this question of paramount importance.

These facts, drawn from absolutely reliable sources, will help to pierce the dense mist of prejudice and erroneous impressions that floats over public opinion, which was misled both by the deceitful appearance of the natural conditions of the two canal routes of Nicaragua and Panama, and at the same time by the false idea that the Panama enterprise was paralyzed by technical impossibilities, when, on the contrary, the financial difficulties were the only cause of such paralysis, and came when, after a long struggle, all technical problems had been entirely solved.

It would have been a short time ago impossible to make the same demonstrations with the same authoritative statements because, though the facts that I could have brought had been the same, I would have been obliged to place them under the authority of the books that I published nine years ago, and I would have hesitated to ask from you so much credit for them.

To-day the situation is changed; an official commission formed of the most prominent engineers of this great country, so rich in eminent engineers, has thoroughly studied the question, and though they have presented but a preliminary report, which did not embrace all the points of this complicated question, nevertheless the facts already definitively settled by this high court of technical skill are so numerous and so precisely stated that a stable and permanent basis is at last offered for a clear, open, and loyal examination of the question.

In order to avoid any confusion about the authority of the statements that I am going to make before you I shall divide my speech into two distinct parts, which correspond to two natural divisions, from the point of view of the subject examined and from that of the authorities which cover the statements.

I am going first to submit to comparative examination all the points that characterize the routes of the Nicaragua and Panama from the point of view of construction or operation.

For the first part I shall not give any figures that are not extracted from the two American official reports on the subject, namely: The preliminary report of the Isthmian Canal Commission of November 30, 1900, and the report of the Nicaragua Canal Commission, 1897-1899.

Only some figures referring to the curves of the Panama Canal, and which are not to be found in said reports, will be extracted from the report of the Comité Technique of the Compagnie Nouvelle de Panama, made under the authority of first-rank engineers of America, England, Germany, and France; also some figures about the Chagres floods will be extracted from public documents of said Compagnie.

In the second part the facts that I shall state in relation to the stability of the construction are not given under the authority of the Isthmian Canal Commission, who did not speak of that part of the subject in the preliminary report, and some facts only will be extracted from the report of the Nicaragua Canal Commission.

Before going into the discussion let us first have a look at the external appearance of the two routes.

APPARENT RELATIVE VALUE OF NICARAGUA AND OF PANAMA ROUTES.

The Nicaragua Lake is separated from the Pacific by a narrow isthmus of 17 miles in width, whose divide is very low (44 feet above the lake), while the Panama Isthmus is 45 miles wide, and its continental divide 330 feet above the sea. This exterior aspect is, I think, responsible for the false ideas formed in public opinion about the easiness of the Nicaragua Canal construction, because one is led to forget that the real and immense difficulties are not on the western side of the lake, but on the eastern side, in the valley of the San Juan (120 miles long), which a superficial examination leads one to consider as a natural waterway between the lake and the Atlantic, which it is far from being in reality.

Owing to that erroneous impression people generally believe that only a very short canal navigation will be met on the Nicaragua Isthmus, and that during nearly all the time of transit from ocean to ocean, ships will float in free deep water.

PART I.

Respective Lengths of Canal Navigation.—There is an evident impossibility of utilizing the lower half of the San Juan for canal navigation, on account of the immense amount of sand brought into it by torrential and powerful tributaries coming from the volcanoes of Costa Rica.

Mr. Menocal, though abandoning the lower San Juan, hoped to replace that part of the river by two artificial lakes, formed by damming two northern tributaries of the lower San Juan, the San Francisco and the Deseado.

He further projected, in the Isthmus of Rivas, a third artificial lake between the Nicaragua Lake and the Pacific.

Those three lakes, as well as the San Juan River, between the Lake Nicaragua and the Ochoa dam, had to be kept at the same level as the lake itself. This route seemed to transform into reality the advantage which the Nicaragua route appears to have, namely, a short canal navigation, combined with the long free navigation in deep water.

This is how it was often asserted that under that plan, if not exactly 17 miles canal navigation, at least not more than 28 miles had to be expected between the oceans.

I showed in 1892 that this figure was much too low, and that 85 miles of canal navigation had to be met, if one takes into account all parts of the way, where ships have to navigate in a channel dug either in open land, or below the bed of a river, or below the bottom of a lake.

I pointed out also to what extraordinary difficulties such an extraordinary amount of damming would lead, and the danger of receiving above the Ochoa dam such tributaries as the San Carlos, with its enormous amount of sand.

The Isthmian Canal Commission, and before them the Nicaragua Canal Commission, rejected the Menocal plan as impossible, and thought that the first place admissible for the location of a dam was above the mouth of the San Carlos.

According to figures given by the Isthmian Canal Commission, the total length of canal navigation, under the plans they adopted, will be 120.53 miles, to which are to be added 66 miles that will be made in free deep water, either in river or in lake, making a total of 186.53 miles from ocean to ocean.

Of that total length of 120.53 miles of canal navigation, 22.19 miles will belong to an artificial channel dug below the bottom of Nicaragua Lake, and 27.96 miles to an artificial channel dug through sand and silt below the bed of the upper San Juan River, of which the larger part will be more than 16 feet below the natural level of the bed of that great river, which carries in flood 100,000 cubic feet of water per second, half given by the lake itself and the other half by lateral tributaries. Outside of the channels opened below the water 67.33 miles will be dug through open ground, the harbor approaches forming the balance of the total length.

The 66 miles of deep-water navigation are formed by 48.74 miles in Lake Nicaragua, and 17.26 miles in the San Juan, immediately above the dam.

Let us now examine the situation in the Panama Isthmus as it will result by the project adopted by the Isthmian Canal Commission.

In Panama we find but 38 miles of canal navigation, to which must be added 7 miles deep-water navigation through the artificial lake formed above Bohio, by the dam projected there across the Chagres at a distance of 15 miles from the Atlantic Ocean.

In fact, the canal navigation in Panama will be less than one-third that of the Nicaragua route. I need not say how much reality differs from the external and apparent aspects of the two routes in regard to lengths of canal navigation.

Depths of Great Cuts.—The continental divide is in Panama, 330 feet above the level of the oceans, and 274 feet above the bottom of the cut projected by the Isthmian Canal Commission; those measurements applying to the natural and original state of the ground. This is the so-called Culebra cut.

The work executed by the old and the new Panama Company leaves to-day 110 feet excavation to be made above said bottom. It is the deepest cut that remains to be excavated on the line of the Panama Canal. One sees to what to-day is reduced this terrible difficulty of the Culebra, which was really the greatest that the construction of the Panama Canal has met, and which during the first six years of the construction remained as an unsolvable problem.

I have related, in 1892, by what method I had been able to meet that immense difficulty and to take it out of the way of the construction of the Panama Canal. It is to that task that I mostly consecrated the last two years of my presence on the Isthmus of Panama.

Let us now see what aspect the question of deep cuts on the Nicaragua Isthmus presents.

On the Nicaragua route, we find that the continental divide is not the place where the deepest cut is necessary.

As already stated, the cut at the continental divide is insignificant (44 feet above the lake), but a high cut of 297 feet above the bottom and others of 218 and 170 are to be met in the low valley of the San Juan to go through high ridges projecting in said valley.

These facts show that most unexpectedly the Nicaragua location is, from the point of view of depth of cuts, by far the worse of the two routes, and that the ratio of 1 to 3 in favor of Panama is to be found equally for length of canal navigation and depth of cuts.

Dams.—I will not weary you about details of technical descriptions as to the relative importance of the two dams to be built, either in Nicaragua or in Panama. Let me only say that the Isthmian Canal Commission stated that the dam to be built in Panama can be built of earth as well as of masonry, which indicates that neither its difficulty nor its cost is extraordinary, and that the same Commission, speaking of the Boca San Carlos dam, on the Nicaragua route, said that "the most difficult engineering work in connection with the Nicaragua Canal project is the construction of a dam across the San Juan River to hold back the waters of the lake, and enable its level to be regulated."

This dam would necessitate compressed air foundations to a depth of 100 feet below low-water level of the river, and have a total height of 150 feet from the crest to the foundation.

The Commission estimates that eight years would be necessary for its construction.

Chagres Regulation.—Let me add that the dam to be constructed at Bohio (Panama) does away entirely with this monster of imagination called the Chagres. What has been said of the Chagres, and the difficulty its regulation presents, has been immensely exaggerated. The Commission has proposed to build a dam in order to form a lake whose normal level would be at 85 feet above the sea. The outlet of that lake will be 2,000 feet wide, and the surface of the lake combined with the dimensions of the outlet are such that the largest floods ever known will be incapable of raising the surface of the lake more than a little over 5 feet. I do not wish to enter into tiresome technical details, but I trust you will accept the statement about the easy regulation of the Chagres, because it is a conclusion arrived at by the eminent American Commission itself.

We have seen when speaking of deep cuts to what the Culebra difficulty, which was a great and real one, is to-day reduced; we have also seen to what the Chagres difficulty, which was never a real one, has been reduced.

Culebra and Chagres are the two names that symbolize in public sentiment the impossibilities of a passage through the Panama Isthmus. Both of them must be totally erased and disappear from the public mind.

Locks.—In reference to the locks which will be constructed, it will be sufficient for me to state that nine locks will be necessary in Nicaragua and only five in Panama, and that the level to which the ships will have to be lifted will be, in the case of the Nicaragua route, 110 feet at maximum, and, under equal conditions at Panama, 90 feet.

The foundation of all locks in Panama will be on rock, and only five in Nicaragua will enjoy such advantages; the other four, say the Commission, "are located on foundations that are believed to be safe."

Nicaragua Gales.—The winds in the Nicaragua Canal location are practically violent and permanent.

This is the result of the geographical situation of the San Juan Valley, open to the trade winds and parallel to their general direction. The lateral high mountains of Nicaragua and Costa Rica form a barrier to the continuous trade winds, which is only open through the San Juan depression. Those continuous and violent gales, much heavier than trade winds at sea, will be a great obstacle, and a great danger for navigators. In Panama nothing of the sort is to be feared, as the Canal is in a direction from northwest to southeast, perpendicular to the trade winds. Lateral mountains shelter absolutely the Canal from any access of trade winds.

Currents.—Concerning river currents, it will be easily understood that, the San Juan River having a much larger watershed than the Chagres, and the Nicaragua Isthmus being much more rainy (from 2 to 2½ times more than the Isthmus of Panama), the quantity of water, though its flow is regulated by the Nicaragua Lake, will be much greater, and generate much more permanent and intense currents than will be the case in Panama, where the great floods of the river are of very short duration, and do not occur at more frequent intervals than three years or more.

To illustrate this state of things, the appendices to the Nicaragua Canal Commission's report and the official documents of the Panama Canal Company give most interesting figures. From measurements taken during ten consecutive years (1889 to 1898), at Gamboa, at the beginning of the five miles where the Chagres and the Canal will be in the same location, the average discharge of the Chagres has been 3,400 cubic feet a second, and the average discharge during the last six months of every year has been 4,800 cubic feet a second.

Measurements taken in 1898 in the San Juan River show that the average mean discharge above the mouth of the San Carlos has been 25,000 cubic feet a second for the whole year, and 31,400 for the last six months.

This shows the relative importance of the two rivers. And at the same time it must be borne in mind that the rainfall at the Atlantic terminus of the Nicaragua Canal at Greytown in 1898 was only 201.64 inches, while the other figures given in the Nicaragua Commission's report are 296.64 inches for 1890, 214.27 inches for 1891, 291.20 inches for 1892, these being the only years when the rainfall was reported for Greytown. It shows that the figures above given for river discharges in Nicaragua are more like a minimum than anything else and that probably half more may be often expected.

In the same comparatively dry year of 1898, the average of the maximum discharge of the San Juan measured in every one of the last six months of the year was 45,500 cubic feet a second, the highest maximum discharge for that period being 50,500 cubic feet a second, in November. (Measurements above mouth of San Carlos.)

In the Chagres in the last twenty-one years five great exceptional floods have taken place, which lasted only a few hours and gave at Gamboa a discharge of 72,000 cubic feet a second in 1879, 58,000 cubic feet a second in 1885, 58,000 cubic feet a second in 1888, 58,000 cubic feet a second in 1890, and 42,000 in 1893.

It is obvious that the great floods of the Chagres, which may be considered as an exceptional incident, lasted for two or three days, and occurring at very rare intervals, give about the same amount of water if not less as the average monthly winter great flows in the San Juan above the mouth of the San Carlos River.

Maintenance of the Canal Channel in the Bed of the San Juan River.—What will be the effect of each flow on the maintenance of the canal channel dug into the bed of the San Juan is extremely difficult to calculate.

There is not a part of the technical science where man feels more the weakness of human knowledge than in such a question.

The form of the bed of a big river is the resultant of the very complicated mechanism of different factors associated together, namely, the amount of water discharged, the variation to which the discharge is submitted, the quantity of gravel, sand, or silt carried by the floods, the relative densities of those materials, the obstacles met by the river, the declivity of the country on which it flows, etc.

It is impossible to calculate the part every one of those factors has in the definitive determination of the form of the bed, but it may be stated that when the industry of man makes it necessary to change with brutality the natural form of the bed, and to transform it into a new channel, this channel, if in harmony with our needs, is in absolute contradiction with the natural needs of the river, and one may expect to sustain with nature one of the most dangerous struggles, one of those where man has been often totally defeated.

A striking example of the variety of forms that a river bed can take is precisely offered by the San Juan above and below its junction with the San Carlos.

From the Machuca Rapids to the mouth of the San Carlos, a distance of about fifteen miles, the San Juan has a very deep bed, 40 and even 44 feet in

* Address to the Chamber of Commerce of the City of New York.

some places at low water, and very little fall, about one foot for the whole distance.

Below the mouth of the San Juan to Ochoa the bed is about 12 feet deep at low water, and the fall 6 feet for 3 miles.

The river is in that latter part twice wider (in rough figures) than above the San Carlos mouth.

Of course the inclination of the water surface, associated with its reduced depth, generates a sensible current, even in very low water, below the mouth of the San Carlos, while, on the contrary, the water runs very sluggishly in the deep bed above.

On account of this sluggishness in that part of the river, it was termed "Agua muerta" (Dead water).

The first impression given by the existence of such a deep channel where water is very low conveys the idea that the river has been unable to fill up the bed with sand or silt as it did below the mouth of the San Carlos, and that therefore the waters of the San Juan River are exceptionally clear. But a closer examination dismisses this impression.

It would be necessary to imagine that the San Juan waters above the San Carlos are as pure as distilled water, to think that in the course of centuries their sediments could not fill the bottom of that channel.

The cause must evidently be referred not to the scarcity of sediments but to the impossibility for the stream to gain room in width on account of lateral obstacles. Probably no other way was left to the river, to convey the mass of water that has to pass periodically in floods, but to dig into its proper bed a deep channel for itself.

As soon as the flood is over and the temporary fall created by the very flood has disappeared, the river takes a sleepy aspect which does not throw any light on the quantity of sediment that has passed during the flood, and that will stay in the bed if the natural conditions are altered by the intervention of man, if, namely, the section through which water has masses of water in floods and enormous masses of sediment.

In the absence of precise data some very probable notion may be formed of the relative importance of the Poco Sol.

The San Carlos has a drainage area of 1,450 square miles. The Sarapiqui has a drainage area of 1,100 square miles. The drainage area of the Poco Sol has not been given, but the drainage area of the tributaries of the San Juan from the Savalos River to a point near and above the San Carlos is 750 square miles. The only important tributary in that section of the river is the Poco Sol, and its watershed may be estimated with that of the Poco Solito as at least between half and two-thirds of the total surface.

One may say for the sake of comparison that the drainage area of the Poco Sol is between one-quarter and one-third of that of the San Carlos, that it comes from the very same volcanic region as the San Carlos and flows on the very same ground. The natural consequence ought to be that it brings a proportional quantity of water and sediment. We have a statement which confirms that view in what regards water discharge.

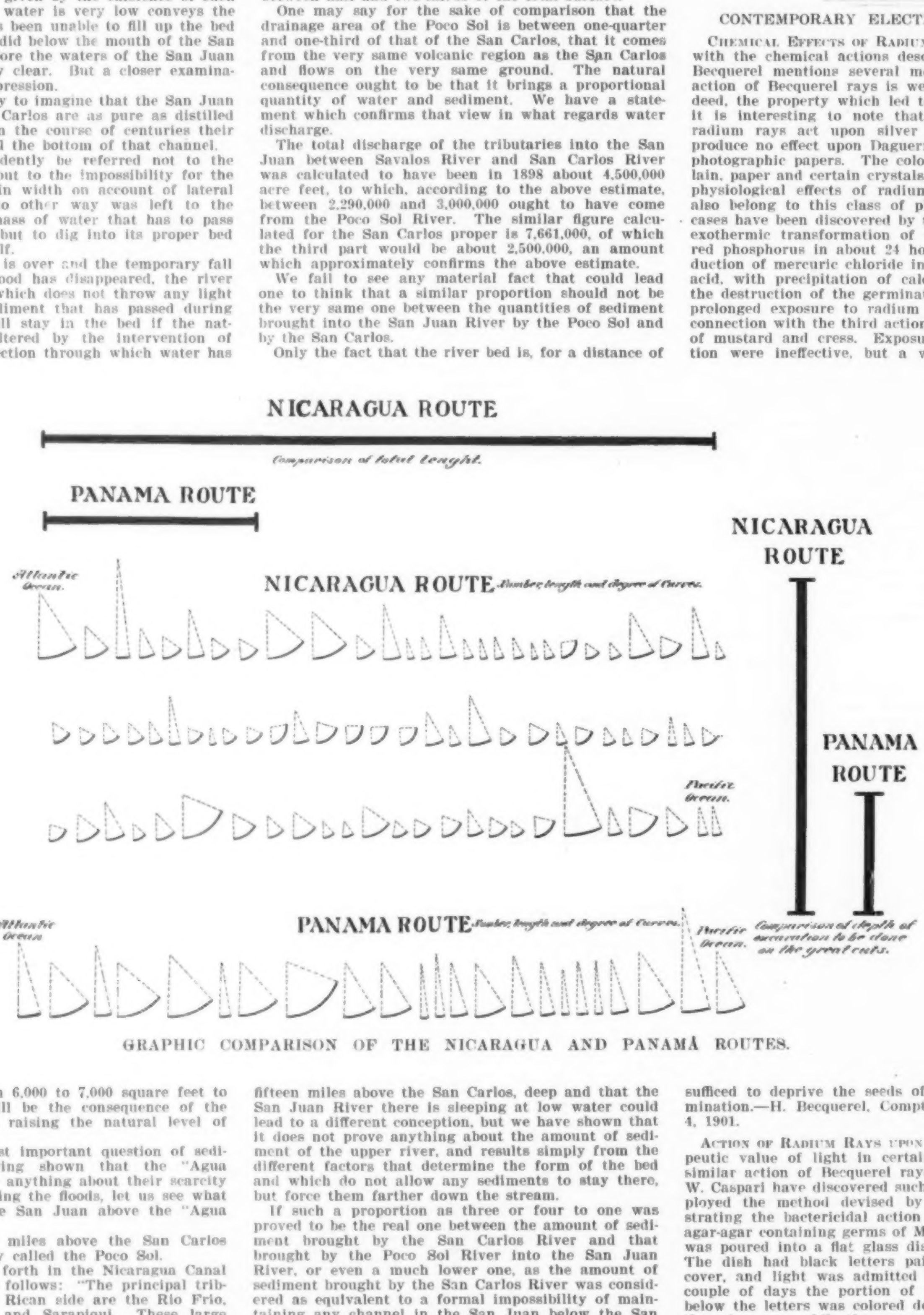
The total discharge of the tributaries into the San Juan between Savalos River and San Carlos River was calculated to have been in 1898 about 4,500,000 acre feet, to which, according to the above estimate, between 2,290,000 and 3,000,000 ought to have come from the Poco Sol River. The similar figure calculated for the San Carlos proper is 7,661,000, of which the third part would be about 2,500,000, an amount which approximately confirms the above estimate.

We fail to see any material fact that could lead one to think that a similar proportion should not be the very same one between the quantities of sediment brought into the San Juan River by the Poco Sol and by the San Carlos.

Only the fact that the river bed is, for a distance of and digs the convex side, and when it changes its curvature from one side to the other, the river expands and fills up its channel to get an intermediary state for passing from the deep channel on one side to the deep channel on the other side.

This any great river will do constantly with the proper elements of its bed without borrowing any foreign material, and the problem, even without any intervention of sediments from lateral tributaries, is a difficult one to solve. The difficulty can, of course, easily go over the boundaries of human practicability when the question becomes complicated with that of great masses of sediment brought into the bed.

(To be continued.)



GRAPHIC COMPARISON OF THE NICARAGUA AND PANAMÁ ROUTES.

to flow is brought from 6,000 to 7,000 square feet to 40,000 or 50,000, as will be the consequence of the construction of a dam raising the natural level of water about 50 feet.

Returning to the most important question of sediments, and after having shown that the "Agua muerta" does not prove anything about their scarcity or their abundance during the floods, let us see what tributaries fall into the San Juan above the "Agua muerta."

We see about thirty miles above the San Carlos mouth a great tributary called the Poco Sol.

This tributary is set forth in the Nicaragua Canal Commission's report as follows: "The principal tributaries from the Costa Rican side are the Rio Frio, Poco Sol, San Carlos, and Sarapiqui. These large sterams exert a controlling influence in confining the location of the canal to the left bank."

In the geological report we find this river alluded to as follows: "The San Juan River receives only small tributaries from the north, while it receives both small and large from the south. The large tributaries include the Frio, Poco Sol, San Carlos, and Sarapiqui. *These all head upon the slopes of the Costa Rican volcanic range* which forms the southern margin of the Nicaraguan depression."

To judge the influence of the entrance of such a stream in the middle of the section of the San Juan which will be consecrated to canal navigation, it would be very desirable to have exact measurements of the volume of its discharge and of the quantity of sediments brought.

Unfortunately no measurements of that large stream were reported by the Nicaragua Canal Commission, as has been done for the three other great and torrential tributaries falling from the slopes of the volcanic range of Costa Rica, namely, the Frio at the west of the Poco Sol and the San Carlos and Sarapiqui at its east, all three bringing enormous fifteen miles above the San Carlos, deep and that the San Juan River there is sleeping at low water could lead to a different conception, but we have shown that it does not prove anything about the amount of sediment of the upper river, and results simply from the different factors that determine the form of the bed and which do not allow any sediments to stay there, but force them farther down the stream.

If such a proportion as three or four to one was proved to be the real one between the amount of sediment brought by the San Carlos River and that brought by the Poco Sol River into the San Juan River, or even a much lower one, as the amount of sediment brought by the San Carlos River was considered as equivalent to a formal impossibility of maintaining any channel in the San Juan below the San Carlos, the maintenance of the depth and width of the canal channel in the same river between the Poco Sol and the San Carlos, which was estimated by the Isthmian Canal Commission as being within the limits of practicability, could not fail to be an extremely difficult one.

Most likely the exact determination of the watershed of the Poco Sol, from precise surveys in the volcanic region from whence it comes, as well as its mean and flood discharge, and the appreciation of the amount of its sediment in flood, as much as can be done by experimental tests, will be found in the definitive report of the Isthmian Canal Commission, and will settle this very important point.

We shall finish the study of this chapter by saying that even leaving aside the amount of sediment carried by the river or thrown into it by its tributaries, the maintenance of a channel of the required width and depth is by itself a very difficult problem in such a powerful stream as the San Juan.

Nature does not like a regular depth and width in the bed of a great river; it is contrary to its laws. In curves the river fills up the concave side of its bed

CONTEMPORARY ELECTRICAL SCIENCE.*

Chemical Effects of Radium Rays.—In connection with the chemical actions described by Berthelot, H. Becquerel mentions several more. The photographic action of Becquerel rays is well known, and was, indeed, the property which led to their discovery. But it is interesting to note that though uranium and radium rays act upon silver gelatino-bromide, they produce no effect upon Daguerre plates or upon some photographic papers. The colorations of glass, porcelain, paper and certain crystals, as well as the painful physiological effects of radium rays upon the skin, also belong to this class of phenomena. Three new cases have been discovered by the author. One is the exothermic transformation of white phosphorus into red phosphorus in about 24 hours, another is the reduction of mercuric chloride in the presence of oxalic acid, with precipitation of calomel, and the third is the destruction of the germinating power of seeds by prolonged exposure to radium rays. Experiments in connection with the third action were made with seeds of mustard and cress. Exposures of 24 hours' duration were ineffective, but a week's exposure amply sufficed to deprive the seeds of their powers of germination.—H. Becquerel, Comptes Rendus, November 4, 1901.

Action of Radium Rays upon Bacteria.—The therapeutic value of light in certain diseases suggests a similar action of Becquerel rays. E. Aschkinass and W. Caspari have discovered such an action. They employed the method devised by Buchner for demonstrating the bactericidal action of light. A layer of agar-agar containing germs of Micrococcus prodigiosus was poured into a flat glass dish and allowed to set. The dish had black letters painted or stuck on its cover, and light was admitted from above. After a couple of days the portion of the nutritive medium below the letters was colored deep red by colonies of the micrococus, while the exposed portions were quite clear. On exposing a similar culture to a radium preparation contained in an aluminium capsule no effect was produced. But an exposure to the rays from the bare preparation killed the germs very effectively in about three hours. The authors made sure that the effect was neither due to phosphorescence nor to ionized air, nor to bromine vapor. This shows that the effective rays are those which are more easily absorbed, and the physical distinction between the two classes of radium rays is thus emphasized by a marked physiological difference.—Aschkinass and Caspari, Ann. der Physik, No. 11, 1901.

Secular Variation of the Earth's Magnetism.—V. Raulin claims to have discovered a revolution of the north magnetic pole about the geographical pole along the 70th parallel of latitude, and maintains that such a revolution would explain all the secular variation observations made in Europe and in the Atlantic. The period of the revolution is 600 years. In 1664 the declination was zero at Paris. In 1580 it was

* Compiled by E. E. Fournier d'Albe in The Electrician.

11 deg. 30 min. east. In 1814 it reached its greatest western value (22 deg. 34 min.). Since then it has undergone a steady diminution. In 2264 the pole will have completed its revolution, and arrived back in the meridian of Paris. The dip must decrease from the maximum of the first observation in 1671 (75 deg.) all the time until the arrival of the pole in the meridian of Paris. This it has done steadily so far. For in 1814 it was 68 deg. 36 min., in 1830 67 deg. 40 min., and in 1865 it was 65 deg. 58 min. Its minimum will probably be 62 deg. 12 min. The author suggests as a cause of this motion a lagging of the liquid or viscous center of the earth behind the crust in its revolution toward the east.—V. Raulin, Comptes Rendus, November 4, 1901.

BICYCLE DIFFERENTIAL GEARS.

THERE has been much discussion as to how high a gear ought to be given to a bicycle, but no agreement has as yet been reached. Some recommend the low

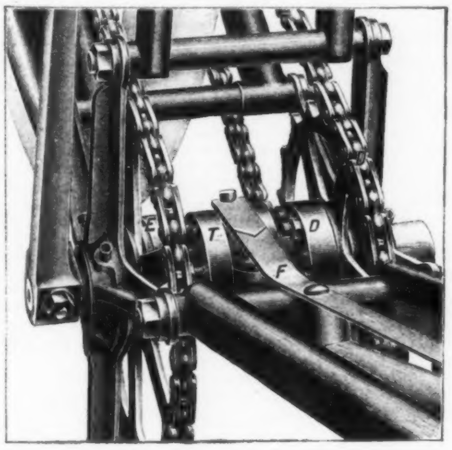


FIG. 1.—THE BELLAN CHANGE OF SPEED.

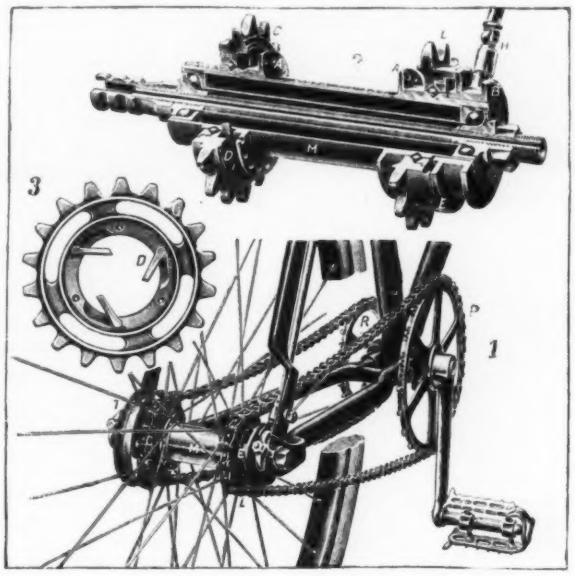


FIG. 2.—THE HIRONDELLE CHANGE OF SPEED.

gear of from 44 to 55 inches, while others are unwilling to admit than anything lower than 6 feet should be used, and even recommend 7.8 and 8 feet.

It is certainly more agreeable to move forward 26.25 feet than 9.8 feet at every revolution of the pedal, and the high gear would be perfect if one were always upon level ground, but, as soon as there is a gradient of but 1 to 100, such a gear causes fatigue. According to M. C. Bouriet, who is an authority upon the subject, it would be impossible to ascend a gradient of 2 to 100 with an 8-foot gear without exertion and without getting out of breath. On the other hand, although a low gear of 38 inches permits of climbing slopes of about one inch to the foot without fatigue, it necessitates a much greater number of motions upon a level as well as upon an incline, and this also is a cause of fatigue.

So, for the most widely used types, a mean of 60 or 72 inches has naturally been adopted. Yet, in order to satisfy every one, a machine has been needed that could, at the will of the cyclist, be changed from a

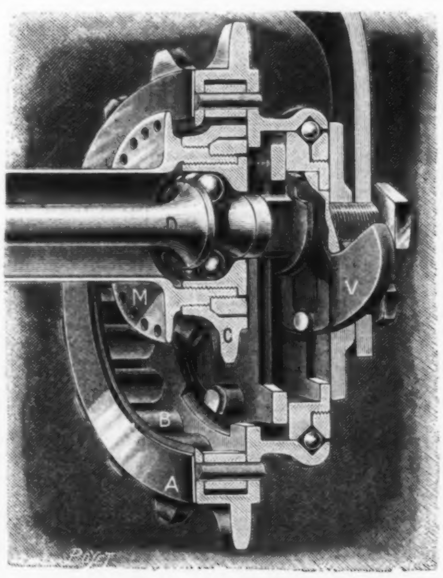


FIG. 3.—THE PEUGEOT CHANGE OF SPEED.

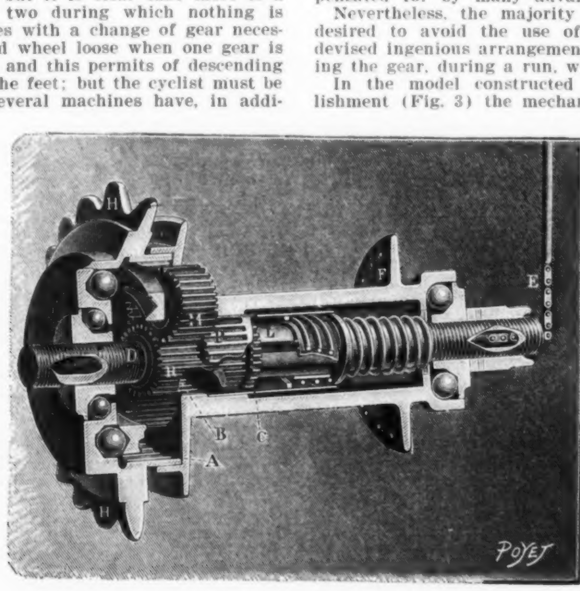


FIG. 4.—THE CLEMENT CHANGE OF SPEED.

low to a high gear, and inversely. Manufacturers have been trying to effect a practical solution of this problem for a long time, and some of them have produced machines which, although still subject to a few criticisms, are giving excellent results.

Some have been content to mount two different sprockets upon the machine and to construct a chain that is capable of being quickly shifted from one sprocket to the other, according to the state of the road. Such a solution is simple; but, since it is necessary to dismount from the machine and spend about five minutes in effecting the change, it is practical only for a tourist, who, in making long excursions, may have occasion to change his gear from low to high, according as he is in a hilly or level country, and preserve the same gear for several days. Such a solution, however, is merely provisional, and is inadmissible in the majority of cases. In fact, there are numerous roads that pass along the side of a hill on which there are continual ascents and descents. Each of these may be of but a few hundred yards, but that does not alter the fact that at the end of the day the cyclist will have climbed a respectable number of miles.

The gear, then, must be changed from the saddle and by a simple operation. The oldest system of this kind that we have tried is that which M. Bellan applied six or seven years ago to his bicycle the "Va-Partout." We do not know why it has not been constructed industrially. It certainly ought to be, since it is very simple and operates very well. The axle of the pedals (Fig. 1.) actuates a sleeve, *T*, that always revolves with it, but which is capable of moving nearly half an inch to the right and left. The machine has two complete systems of gears, each comprising a large toothed wheel, *E* and *D*, a chain and a sprocket. One of them is placed to the right and the other to the left of the crank bracket. One gives a forward motion of 19.6 feet and the other of 11.5 at every revolution of the pedal. The large toothed wheels are loose upon the pedal axle. When the sleeve is in the center of the latter, it alone is actuated by the motion of the feet; but, through a lever, *F*, one of the extremities of which is fixed to the sleeve, while the other rests against the handle bar, the sleeve may be shifted to the right or left, and, in this case, a circle of strong pins with which it is provided upon the two faces engages with a corresponding circle of apertures in the hub of each toothed wheel; so that the toothed wheel that is in contact with the sleeve becomes operatively connected therewith.

It is therefore possible to change from one gear to the other by a simple shifting of the lever situated near the handle bar; but it is clear that there is a moment between the two during which nothing is actuated. All machines with a change of gear necessarily have the toothed wheel loose when one gear is changed for the other, and this permits of descending hills without moving the feet; but the cyclist must be sure of his brake. Several machines have, in addition, a free wheel upon one of the two gears—generally upon the lower of the two. Let us recall the fact, by the way, that the free wheel (which must not be confounded with the loose wheel) is always actuated by the pedaling forward, but that the pedaling backward has no action upon it, and that it is consequently possible to keep the feet immovable upon the pedals without preventing it from revolving to the front. In some systems of free wheels, a back-pedalling has the effect of causing a brake to act upon the hub.

The use of two complete systems of gears has been adopted likewise by the French manufactory of arms and bicycles at Saint-Etienne. The two chains are situated to the right and left of the frames (Fig. 2, No. 1) as in the preceding machine, but here the large toothed wheels, *R* and *P*, are operatively connected with the pedal axle, and the change is effected upon the axle of the sprockets, *C* and *L* (No. 2), mounted upon the hub, *M*, of the hind wheel. The sprocket, *C*, of the low gear is mounted as a free wheel through clicks, *D* (No. 3), placed in the interior of the rim. It therefore offers no interference when the high gear is employed. The sprocket, *L*, corresponding to the latter carries laterally a ring of which the face is provided with notches and opposite which is another ring, *E*, provided with corresponding notches. This ring is operatively connected with the hub and performs the part of an actuating sleeve when it is brought near the face of the sprocket. Its displacement is effected by means of a wheel, *B* (No. 2), which revolves in a channel formed in its circumference. It is mounted at the extremity of a rod, *H*, that is slightly eccentric. This rod, through jointed segments, is prolonged to a point within reach of the hand of the cyclist, who, upon giving a half-revolution, to the right or left, of the eccentric part that carries the wheel, forces the sleeve, *E*, to move to one side or the other and engage with or free itself from the sprocket, *L*.

This machine has been constructed for two years and gives excellent results. Its mechanism is plain and simple, and, although it is not protected by any casing, it never gets out of order through the effect of mud or dust. On the contrary, the manufacturers are of the opinion that it is important to leave all the parts visible and easy of inspection.

The objection has been made to these machines that they use two chains, which render them heavy and necessitate additional trouble to keep them in repair; but, in practice, it is found that such objections are not as serious as might be thought, and are compensated for by many advantages.

Nevertheless, the majority of manufacturers have desired to avoid the use of two chains, and have devised ingenious arrangements that permit of changing the gear, during a run, with a single chain.

In the model constructed by the Peugeot establishment (Fig. 3) the mechanism is placed upon the hub of the hind wheel. The toothed wheel, *A*, which is actuated by the chain, carries, in the interior, rollers, *B*, that form, so to speak, the links of a second chain capable of actuating a sprocket, *C*, keyed upon the axle. The toothed wheel, *A*, may be slightly displaced vertically so as to cause it to slide in a groove and may be secured in the position desired by means of a bolt, *V*. Such displacing and fixing are effected at once by means of a maneuvering rod the extremity of which is within reach of the hand. After the wheel, *A*, has been completely lowered (as shown in the engraving) the chain continues to actuate it; but it no longer acts directly upon the hub. Through the intermedium of the rollers, *B*, that form a second chain concentric with the first, it actuates the sprocket keyed to the axle of the driving wheel, and this gives a high speed. If, on the contrary, the wheel, *A*, be raised so that the axle, *D*, and consequently the

sprocket, *C*, shall be in the center, the teeth of the latter will be disengaged from the rollers, *B*, but, on another hand, will engage with pins that render it and the wheel, *A*, interdependent. It will then revolve with the latter and carry along the hub upon which it is fixed, and a low speed will be obtained.

In the intermediate position, that is to say, after the sprocket has left the rollers, *B*, but has not as yet engaged with the pins that secure it, we have the loose wheel.

We now come to another arrangement (Fig. 4) which has been devised by the Clement establishment, and which is distinguished from all others by dimensions so small as to permit of its being entirely concealed in the hub of the wheel, so that no one would suspect its existence.

The toothed wheel, *H*, which is actuated by the chain, is mounted upon the perimeter of an internal gearing, the teeth of which mesh with those of four small sprockets, *M*, fixed upon the rim of the hub, *F*. Internally, at one of its extremities, the latter is provided with teeth, *B*. The axle, *D*, is hollow and carries a sprocket, *R P*, which itself carries an internal sprocket, *C*, and is traversed by a steel rod provided with a snug that may be displaced by pulling a chain, *E*, which is connected by a steel wire with a handle placed near the handle bar. It is through the displacement of the snug that it is possible, at will, to throw into engagement the different sprockets mounted upon the axle. For a high speed it is the sprocket, *P*, which receiving motion from *H* through the intermedium of the sprockets, *M* and *B*, actuates the hub through the toothing, *B*. But, if the axle be displaced, the sprocket, *P*, will be disengaged and the motion will then be transmitted through the small sprocket, *C*, and the speed will consequently be reduced. At the moment at which one speed is changed for the other the hub will be completely disengaged and we shall have a loose wheel.

This system is very elegant, but has appeared to us to be somewhat delicate. It has, however, been applied for more than two years to quite a large number of machines and has always operated well. In all machines provided with a change of gear, it is necessary to cause an intervention of the loose wheel between the two changes of speed; but this does not prevent our having a free wheel, in addition, upon one of the two changes of speed. Consequently, it is indispensable to have an excellent brake either upon the hub or felly, or often upon both.—For the above particulars and the illustrations, we are indebted to La Nature.

ROBERT FULTON.*

IT seems strange that the great American inventor and engineer Robert Fulton should have had to wait eighty-six years before a monument was erected to his memory. The American Society of Mechanical Engineers raised by subscription a considerable fund for use for this purpose, and the monument in Trinity burying-ground on Broadway, at the head of Wall Street, was unveiled on December 5 with appropriate ceremonies. The exercises were held in the Real Estate Exchange and in Trinity Church. In the former addresses were given by George W. Melville, Rear-Admiral and Engineer-in-Chief, U. S. N., and by Dr. R. H. Thurston. Through Admiral Melville's courtesy we are enabled to present our readers with his interesting address.

> Death makes no conquest of this conqueror;
> For now he lives in fame, though not in life.
>
> Here the reward stands for thee. A chief seat
> In fame's fair sanctuary, where some of old,
> Crown'd with their troubles, now are here enroll'd
> In memory's sacred sweetness to all ages.

We are assembled here to do honor to the memory of a great American and a great engineer—to the memory of one whose work led, in its development, to the utmost benefits and blessings to mankind. Without exaggeration it can be truly said that among the world's foremost benefactors stands Robert Fulton, the American engineer, whose monument we are dedicating to-day.

Though Fulton's achievements were not at first thoroughly understood nor appreciated by his countrymen, and though he has not been always given that credit which he deserves by foreign writers, it may be said that the success of Fulton in the practical establishment of steam navigation was so marked an event in history that since his death his memory has been honored by the American people and his merits generally recognized the world over. Of him there have been scores of memorials written; and in different periods of our history government and merchant vessels have borne his name. Other substantial marks of respect have been paid to his memory. Here in New York you have daily reminders of Fulton in the *Fulton* Ferry (which he started, and which up to the time of the construction of the Brooklyn Bridge was the chief means of transportation between New York and Brooklyn) and in *Fulton* Street and in the *Fulton* Market. But while there is actually needed, perhaps, no further expression of our appreciation of his greatness to keep him in remembrance, it is meet that we should at last erect this monument to his memory. As engineers we feel it especially incumbent upon us to discharge this loving duty.

Toward the close of the eighteenth century, when the steam engine had but lately been sent forth on its worldwide mission by its master, it was natural that the thoughts and energies of many men should turn to the application of so marvelous a factor for material development—a factor fraught with such practical promise. Connected with the introduction of that important branch of the steam engine's application, steam navigation, history discloses a cluster of inventors, engineers or mechanics of different nationalities (including a number of Americans besides Robert Fulton) of varying force of character, originality, mechanical aptitude and business ability.

It is not likely, after this lapse of history, when the merits of the different men who attempted to construct a commercially successful steamboat have been thoroughly sifted, that our patriotism would obscure our judgment, and that we should laud Fulton at the expense of others. It is sufficient to say that Fulton was aided in his work by the efforts and partial success of those who had gone before him, and by the general scientific knowledge and engineering experience of his time, as well as by the acquaintance of some of the most able and enterprising men that were engaged in the solution of the world's problems, including Watt himself. He had also the financial aid and the friendship of his fellow-countryman Chancellor Livingston much in the same way that Watt had the material support and encouragement of Mr. Boulton.

But these advantages of themselves could not have insured success, which was the result of Fulton's progressive and courageous spirit, his adaptive and resourceful mind, his originality, practical judgment and unremitting labor.

Without doubt Fulton must be acknowledged to have made that valuable contribution to the world's progress—the commercial establishment of steam navigation.

The claims of any man, of any nation, cannot take from the American engineer Fulton that success which the unanswerable logic of his deeds awards him.

> One thing is forever good;
> That one thing is success.

THE INVENTIVE FACULTY.

When rightly used, the originative faculty is the glory of mankind. It is only by scientific discovery, great invention, and progressive engineering that material advance can be made and civilization be carried onward. For man, the best knowledge is that which is most useful to him, and he who makes successful mechanical applications and improvements is a worldwide philanthropist.

The grand dreamer in mechanics burns with the true spirit of progress. Unfortunately, from habits of abstract thought and insufficient amount of practical experience—which are indeed almost inseparable from his genius—the mechanical seer often is unable to place his discovery within the reach of humanity, and it therefore frequently remains for the more practical inventor and engineer to aid him in interpreting its mechanical advantages and exhausting its commercial possibilities.

Our present conception of the term "inventor" is much wider and more definite than in the past, and it is seen to be more closely connected with scientific experiment and engineering efficiency than was formerly supposed. The inventor in the truest sense of the term is he who, besides having the originative faculty, possesses wide scientific knowledge and practical skill in the design of, and experience with, existing forms of machinery. In addition to these qualities, for an inventor to achieve commercial success with his invention, there must be a natural demand for it; and he must possess the courage and perseverance, the financial means, and the practical ability to put it upon a business basis, or else must intrust it wholly or partly to the hands of others to do so.

The necessity for all of these qualities becomes greater as the machine becomes more complex.

It is, moreover, now thoroughly appreciated that in the design of machinery, the most exacting exercise of the inventive faculty is required, inasmuch as here the mind is working within narrower limits of practicability and a more definiteness of thought and fixity of attention are needed. The designer is approaching the actual construction, and further on, the actual operation, of the machine. Such use of the imagination takes the most sound and disciplined intellect; and the courage and character of the man will be here shown in the results of his work—whether all the details of development have been worked out, or whether the machine, through halfheartedness and slipshod methods on the part of the designer, falls short of its possibilities.

Generally speaking Fulton's claims as the first inventor of the practical steamboat cannot be disputed, since it proved its utility in actual service. As a rule a great mechanical invention is the outgrowth of the combined efforts of several inventors of more than one nation, and in a general sense may be said to be common scientific knowledge; but to the man who actually makes a commercial success of an invention due credit always must be given. Fulton commercially created the steamboat.

There can be no doubt of Fulton's power of originality, which (besides being evidenced by his work of proportioning the machinery to the hull of his vessels, and by the improvements which he made to each successive boat as it was built) may be seen in the work of his whole life, which was in great part taken up with invention and the projection of plans for the world's welfare.

Fulton possessed scientific knowledge and practical skill, was a progressive engineer, and his great work in the establishment and subsequent improvement of the *commercial steamboat* was built upon a firm foundation.

In his methods we note the most careful procedure and the most approved ways and means to attain the results desired. He did not trust to vague theory, but worked out all details and thoroughly tried everything that might be in doubt before attempting to introduce it into actual use.

In securing the confidence and aid of friends Fulton may be said to have had "good fortune," which is at best a most unsatisfactory and indefinite term; but all other requisities for the commercial success of a marked and timely application in the use of the steam engine, Fulton either naturally possessed or else acquired by his industry.

Let us not permit our knowledge of the present advanced state of marine engineering efficiency and practice to dim our conception of Fulton's great work.

Let us recognize his great achievement.

Let us give all honor to Fulton, who by his courage, energy and determination; by his knowledge, skill and practical enterprise; through combat and stress, through trial and labor, through discouragement and inappreciation, overcame opposition, beat down the barriers of conservatism, and turned cold indifference into fervid enthusiasm, and sneering ignorance into unfeigned wonder.

As one possessing the power of invention—or that which is often its practical equivalent, great ability as a progressive engineer and as a business man—Fulton lives in the fame that he so justly earned.

I have dwelt, at some length upon Fulton's share in the introduction of the commercial steamboat, since in going through many old memorials and records of his achievements, glowing with appreciation of his greatest work (to which memorials and records we of this day are indebted for the knowledge of the detailed facts and circumstances attending Fulton's life and labors), one is impressed with the truth that in some cases his claims as the first inventor of the practical steamboat might have been put forth more positively. In the light of a more thorough realization at the present time of the intimate connection between the inventor, the progressive engineer, and the business man, Fulton's genius can be now more generally discerned.

ROBERT FULTON THE MAN.

Robert Fulton was born in Lancaster County, Pennsylvania, in 1765. At an early age he evinced talent as an artist, and by the time he was 21 had achieved such success in painting that he was able to buy a farm for his widowed mother. On the advice of friends he went to England to seek aid from that famous American, Benjamin West, in the further development of his talent for painting. After studying with Mr. West for several years, Fulton started out on his independent career as an artist.

Soon making the acquaintance of several men of science and mechanical ability, the spirit of his true genius—that of mechanics—which had been sleeping awoke and urged him onward to the fulfillment of his destiny. In his earliest days Fulton's true bent had asserted itself. As a boy he had fashioned a paddle-wheel worked by a crank to save himself and his companions the fatigue of poling their boat in their youthful fishing trips on the Conestoga. Moreover, much of his spare time as a lad had been spent among the artisans in the workshops near his home; and before adopting the career of an artist he had learned the trade of a watchmaker.

Seven years after his arrival in England we find Fulton, then only 28 years of age, thoroughly impressed with the idea of the practicability of the steamboat, to which so much of his best thoughts and energies were devoted throughout a great part of the remainder of his life. From views expressed by Fulton about this time (1793) in a letter to Earl Stanhope, on the practicability of a plan for steam navigation, it is the opinion of competent authorities that had Fulton been given the opportunity to then test such views the commercial steamboat would have been a fact ten years prior to the success of the "Clermont," which was launched in 1807.

By 1795, having added to his stock of mechanical knowledge and won honors as an inventor, Fulton was a civil engineer and was writing extensively on technical subjects. He was particularly interested in inland navigation, and appreciated its value as a means for the internal development of the United States.

Crossing the channel to France in 1797 he formed the acquaintance in Paris of Mr. Barlow, who became his lifelong friend. At this time, besides pursuing other studies, Fulton gained a better knowledge of mathematics and physics. It was while in Paris that Fulton experimented with submarine explosives and torpedo-boats. When engaged in experimenting with torpedoes, a man possessing such practical judgment as Fulton must have realized that these weapons could never prove of great value as long as the vessel using them was dependent on the wind, so that we find him in 1801 again turning to the effort to make the steamboat a success.

These efforts, with the encouragement and active co-operation of his friend Chancellor Livingston, were continued at different times, both in France and England, up to the date of Fulton's return to the United States, which was in 1806. He then worked steadily on his great project, and shortly after was rewarded with success.

It was in the early part of the year 1807 that the "Clermont"—fitted with one of Boulton & Watt's engines which Fulton had ordered from England before he left for the United States—was launched from the building yard of Charles Brown, on the East Hudson. At one o'clock on the seventh day of August, 1807, the "Clermont" began her first trip from New York to Albany.

In a letter to Mr. Barlow, Mr. Fulton describes this memorable trip. He says:

"My steamboat voyage to Albany and back has turned out rather more favorable than I had calculated. The distance from New York to Albany is one hundred and fifty miles. I ran it up in thirty-two hours and down in thirty. I had a light breeze against me the whole way, both going and coming, *and the voyage has been performed wholly by the power of the steam engine*. I overtook many sloops and schooners beating to windward, and parted with them as if they had been at anchor. The power of propelling boats by steam is now fully proved. The morning I left New York, there were not perhaps thirty persons in the city who believed that the boat would ever move one mile an hour, or be of the least utility; and while we were putting off from the wharf, which was crowded with spectators, I heard a number of sarcastic remarks. This is the way in which ignorant men compliment what they call philosophers and projectors. Having employed much time, money, and zeal in accomplishing this work, it gives me, as it will you, great pleasure to see it fully answer my expectations. It will give a cheap and quick conveyance to the merchandise on the Mississippi, Missouri, and other great rivers which are now laying open their treasures to the enterprise of our countrymen; and although the prospect of personal emolument has been some inducement to me, *yet I felt infinitely more pleasure in reflecting on the immense advantage that my country will derive from the invention*."

This voyage established steam navigation, and the "Clermont" henceforth made regular trips between New York and Albany.

THE CLERMONT.

The "Clermont" was of 160 tons, was 133 feet long,

* Address read at the Fulton Memorial Exercises, by George W. Melville, Rear Admiral and Engineer-in-Chief, U.S.N., December 5, 1901.

18 feet beam and 7 feet deep. The paddlewheels were 15 feet in diameter, with buckets 4 feet long, with a dip of 2 feet. Later her keel was lengthened to 140 feet.

Once the steamboat became a commercial fact, Fulton was too thorough an engineer to consider his work as accomplished, but immediately began to remedy all defects, which materially increased the "Clermont's" efficiency. And as each new boat was put into service on the Hudson, she was an improvement over the one preceding.

Chancellor Livingston was still associated with Fulton, and in 1811 they built and put into service the first steamboat on the Mississippi, which was named "Orleans."

So well was the work builded by Fulton, that we may say that in its basic principles it still lives—greatly developed, it is true, but still not so changed that anyone could venture to declare that Fulton's share was of little value.

As a member of that profession which Fulton may be said to have founded—Marine Engineering—I feel it a peculiar honor for me to pay my tribute to his genius. As engineers all of us can learn a great lesson from Fulton's labors—that of progressiveness; of not resting content until the full meaure of efficiency, within the limits of safety and economy, has been obtained from each and every one of our works, which is the true test of their worth; and the highest honor that we can pay to his memory is for us to endeavor constantly to keep the profession of engineering in the forefront of progress and thus add lasting benefits and blessings to the world.

The engineer's labors, taken in connection with the advance of science and its marked application (which are themselves often equivalent to engineering in its highest expression), form the basis of all material success in both peace and war—of all social progress. Perhaps it is this fact of the engineer being at the basis of civilization that has made it take so long to "discover" him, *but there can be no doubt of his existence now*. To-day there is a word ringing around the world—it is engineer. Thousands of eyes are turned upon him, and he is the object of the closest scrutiny. Amid such public notice, it is natural that the engineer should be far more conscious of what is required of him than he was in the past; and he is at present regarding himself most earnestly. He does not do this merely to dwell with complacency on his achievements, nor to exaggerate his importance to human welfare (though he may take a proper pride in this); but he is subjecting himself to the most searching analysis, to get a fuller realization of his duties and responsibilities and to thus attain to the greatest possible height of usefulness.

The modern American engineer is wedded to the business world, is an industrial leader, and is a true political economist. He is vitally connected with the efficiency of military organization, holds a high place in the army or navy, and is particularly fitted to understand and apply the principles of war.

Fulton was a member of the original family of American engineers, and the American engineer of the hour is his direct descendant. Fulton was an engineer of character, mindful of his duty and responsibility; an engineer who strove to promote the welfare of his country in peace and war; an engineer who realized the importance of the organization and efficiency of *men* as well as of machines; an engineer who regarded industrial relations from the viewpoint of a practical business man; and an engineer whose dominating purpose was to promote the peace and prosperity of the whole world and to increase the stability and means for defense of his own country; but an engineer who did not permit his lofty conceptions of universal brotherhood and happiness to obstruct that practical habit of thought and course of action which are necessary if prolonged hostilities are to be avoided, and if material benefit is to be bestowed upon the majority of men.

But Fulton was also a *distinguished* member of the original family of American engineers. Fulton was an engineer of exceptional courage, foresight, and mechanical and business ability, which enabled him to achieve great success. As such, he was a great man, a great American, and a great engineer.

THE "DEMOLOGOS," OR "FULTON THE FIRST."

To Fulton belongs the honor not only of having constructed the first commercially successful steamboat for purposes of commerce, but of having built the first steam war vessel in the history of the world. She was the "Demologos," afterward called "Fulton the First." Her keel was laid on June 20, 1814, in this city; and she was launched October 29 in the sight of thousands of spectators. Difficulties in procuring labor and the untimely death of Fulton on February 24, 1815, caused serious delays in the completion of the "Demologos." On her first trial trip in June, 1815, the soundness of Fulton's views, and the fact that a heavy floating battery could be propelled by steam, were established. Her two subsequent trials further demonstrated her success, her speed exceeding Fulton's guarantee to the government. Peace being declared, there was no opportunity to test the vessel in actual combat, and the "Demologos" was sent to the Brooklyn navy yard for a receiving ship, remaining there until June 18, 1829, on which date she was blown up either by accident or design.

The "Demologos" was a double-ended, twin-hulled floating battery of 2,475 tons, carrying twenty 32-pounder guns, protected by 4 feet 10 inches of solid timber. These guns were to fire red-hot balls. The machinery was calculated for the addition of an engine to discharge an immense column of water, intended to be thrown upon the decks and through the ports of an enemy. In addition to all this, two 100-pounder columbiads were to be suspended from each bow, so as to discharge a ball of that size into an enemy's ship, 10 or 12 feet below the water line. It is not surprising that she was, in her day, described as being *the most formidable engine of warfare that human ingenuity has contrived*. The "Demologos" was driven by a single central paddlewheel; her speed was 4½ miles per hour; and she was both handy and seaworthy.

The following extract from a Scotch newspaper is an amusing example of the exaggerative accounts of the "Demologos" that were scattered broadcast. "Her length," says the writer, "on deck is 300 feet; breadth, 200 feet; thickness of sides, 13 feet; of alternate oak plank and corkwood; carries 44 guns, 4 of which are 100-pounders; and further to annoy an enemy attempting to board, can discharge 100 gallons of boiling water in a minute, and by mechanism brandishes 300 cutlasses with the utmost regularity over the gunwales; works also an equal number of heavy iron pikes of great length, darting them from her sides with prodigious force and withdrawing them every quarter of a minute."

As Americans, we can all look upon the first steam war vessel of the world with especial pride, and we can note with gratification that the vessels of our navy to-day are, ton for ton and gun for gun, equal to those of any navy afloat. If it were possible for Fulton to have lived for such a length of time, he would share with us in our pride; and we can imagine what his thoughts and feelings would have been at the splendid achievements of the "Oregon."

There is living in New York to-day a veritable veteran of the engineering profession, who as a boy saw the "Clermont" and the "Demologos," and who as a young man was the designer of the machinery of the second war steamer of the United States, which was called "Fulton the Second." He was also the first engineer officer to be appointed in our navy, and, later, he had the honor to become Engineer-in-Chief. To bridge such a period of history and to have played so important a part in it, is a privilege which comes to very few of us—but this privilege has come, as most of you know without the telling, to Mr. Charles H. Haswell.

When reviewing the world's progress during the nineteenth century, we see that its grandest glory was gained by the steam engine, which has been styled its hero. The work of the stationary steam engine is epitomized in the phrase "increased production;" and the work of the locomotive steam engine on both land and sea is epitomized in the phrase "increased distribution."

With these two phrases, the history of the material progress of the world may be said to be written.

The steam engine sung, in mighty deeds, the "Song o' Steam" throughout the nineteenth century, and at its close a vigorous poet caught up the dominant note of his age and, in vivid tones, set it to swelling and echoing to every corner of the earth.

The duty and destiny of America for the greater part of the nineteenth century was, as my hearers well know, that of internal expansion and development. The practical establishment of steam navigation by Fulton and its further improvement by the many engineers who followed him—chief among whom in this country was the great Robert L. Stevens, son of the famous Colonel John Stevens—played a vital part in this development. In the development of the country the sidewheel steamer found its true destiny; and throughout the past century nobly met the needs of the nation. On our deep sounds and reaching rivers there ply to-day numberless descendants of the "Clermont"—highly efficient and finely equipped—carrying swiftly to their destination both passengers and the burdens of commerce.

To-day the duty and destiny of the nation is for a greater expansion and development; and the hopes, thoughts and interests of the people are turning toward far-away islands and toward the commerce of the seas. If the American inventor or engineer does his part in the solution of the problems of the present century as well as Fulton did his part in the solution of the problems of the past century, there need be no fear for the continued growth and prosperity of the nation.

We see in Fulton all the qualities that make for the success of America—character, courage, perseverance, energy, enterprise and skill. We see in Fulton the true American spirit—a high, hopeful, progressive, liberty-loving and practical spirit.

Fulton was high-minded and generous, and he was true to his friends in their adversity. He was noted for his amiable disposition and genial hospitality. It was said of him that he was "a gentleman in mind and manners." He was a man of refined tastes, and, besides his active efforts during the most of his lifetime for the promotion of the mechanic arts, it was his endeavor to foster a love for the fine arts; and failing in his project to establish an art gallery in America, he bequeathed to our government at his death two of West's masterpieces which were his most prized and valued possessions.

In closing, it is fitting to reiterate that as an inventor, Fulton earned the highest crown that he could earn—success; and his name should be honored by all inventors. As an engineer, Fulton did all that he could do to promote the welfare of the world, and his name should be honored by all engineers. As an American, Fulton was a true type, and gained glory for his country, and his name should be honored by all Americans.

As such, Robert Fulton was a great engineer, a great American, and a great man; and his memory should be respected the world over, and his name ever revered by our people.

THE ECONOMIC POSITION OF JAPAN.

JAPAN, like other Eastern countries, has often been misjudged by her western critics. For a good many years after the beginning of modern intercourse with foreign nations it was looked upon, to a large extent, simply as a good field for the curio hunter, the artist, and the globe-trotter. The artistic instincts and capabilities of the people were admitted, and the beauty of the country was admired; but even after serious attempts had been made to adopt western methods and ideas, the great majority of people who spoke or wrote about the Japanese refused to give them credit for being more than clever imitators and adaptors. For instance, Sir Harry Parkes, with all his knowledge of the Far East, could only see them as children playing with the fashions of the West, and this opinion was generally shared until the Japanese cannon at the Yalu River placed their unwieldy and unprogressive Chinese neighbor at their mercy. Those who really knew them, however, were well aware that for fully a quarter of a century they had been laying the foundations of a new civilization by a very thorough system of education, and, moreover, that they had made very considerable progress in the applications of western science and methods to industrial production. In several departments, and especially in those connected with the cotton manufacture, Japanese goods are to be found in all the chief markets in the Far East. The Japanese navy forms a very important factor in the forces to be taken into account when estimating the probabilities of any international quarrel in that quarter of the globe. Its army has won admiration, not only for its bravery, but also for the thorough manner in which it is equipped, and the able manner in which it is handled. Japanese merchant ships are to be found in many of the chief ports in all parts of the world, and the place of Japan in the comity of nations has now been admitted, even by her keenest critics. Now, however, the criticism has taken another form, and while they admit the facts which we have stated, they say that they have been accomplished at the expense of what is practically national bankruptcy, and that the country is rapidly drifting to ruin. We have from time to time given some account of the industrial progress of Japan, but as that cannot be considered real unless the financial basis is sound, we will glance at the economic conditions of the country and see how far the pessimistic views are justified.

Our task is very much simplified by the frank manner in which the Japanese government publishes statements of its accounts. The financial annual, which has just been issued by the Department of Finance in Tokyo, contains a vast amount of interesting information, but, of course, we can only note a few of its more important figures. The budget estimates for the current fiscal year, which ends on March 31, give a revenue of 277,497,003 yen, and an expenditure of 275,928,645 yen, and as the yen may, for practical purposes, be taken at 2s., the corresponding figures in pounds sterling is found by dividing the amount in Japanese currency by 10. These figures include both the ordinary and extraordinary revenue and expenditure, and they show an enormous increase in recent years. If we go no further back than 1895-6, we find that for that year the total income was only 118,432,721 yen, and the expenditure 85,317,180 yen, with a surplus of no less than 33,115,541 yen. That was, however, in what has come to be called the ante-bellum days, and later on we will note some of the items which have increased the figures to their present amount. Taxation has grown at a very rapid rate. It has increased from 73,567,908 yen in the first-named year to 138,741,469 yen in the current year. The national debt, notwithstanding the Chinese indemnity, now stands at the very considerable figure of 518,764,195 yen, all of which has been accumulated since 1870, when the first public loan was negotiated. Local loans to the extent of 35,779,922 yen have been raised. All this would be rather alarming if we did not, at the same time, look at the amount of industrial and commercial development during the same period. There are now 873 industrial companies, with an aggregate capital of 192,211,140 yen; 2,518 commercial companies, with an aggregate capital of 483,855,508 yen; 55 railway companies, with an aggregate capital of 276,640,000 yen; and 2,356 banking companies, with an aggregate capital of 504,119,559 yen. The number of companies of all sorts in Japan last year is returned as 5,543, with an aggregate capital of 1,364,799,004 yen; of which 878,154,396 yen was paid up. There is no indication how much of this is foreign capital, but we should imagine that the amount is relatively small.

The publication to which we have referred contains many interesting returns. One, for instance, shows the amount of money in circulation in the different years since 1868, another the rates of interest throughout the empire, and a third the value of the imports and exports. We have, however, from time to time given information on some of these points, and we need not go into details regarding them in the meantime. The table relating to the amount of tonnage of steam vessels entered at ports in Japan is very interesting. Last year the total number was 5,330, with a tonnage of 9,606,752 tons, and of these 2,645 were Japanese ships, with a tonnage of 3,363,657 tons, a most remarkable development when we remember that a quarter of a century ago the Japanese had no steamships. The total number of sailing ships which last year entered at ports in Japan from foreign countries was 1,300, with a tonnage of 218,870, and of these 614, with a tonnage of 56,951, were Japanese vessels, besides 558 junks, of a total tonnage of 5,923. The table showing the total number and tonnage of vessels belonging to the Empire of Japan from 1870 to 1899 is very instructive. In the first-named of these years there were 35 steam vessels, with a total registered tonnage of 15,498, and 11 sailing vessels, with a total registered tonnage of 2,454, or a total number of vessels of 46 and a tonnage of 17,952. In 1899 the number of steam vessels was 1,221, with a total registered tonnage of 315,168, and of sailing vessels 3,322, with a total registered tonnage of 269,032, or a total number of vessels of 4,543 and a tonnage of 584,200. In 1872 there were only 18 miles of railway in the whole country, while in 1899 the length of line opened to traffic was 3,635 miles. The statistics relating to posts, telegraphs, and telephones show equal progress, but we need not meantime go into details of the figures.

The report to which we have been referring is for the most part confined to bare statistics, and critics of Japan may say that while the correctness of these figures may be admitted, they show nothing of the actual financial condition of the country. For some idea of that we must turn to another report on the post-bellum financial administration in Japan, 1896-1900, by Count Matsukata Masayoshi, recently Minister of State for Finance. An excellent resumé of that report, by a well-informed writer, appears in the Monthly Review for October. It is out of our sphere to enter into details of finance; for these we must refer to the publications mentioned, and we will simply note a few of the most important points and conclusions. Count Matsukata admits the increase in the expenditure of Japan is startling, and he goes on to give particulars of the programme which caused it.

We have in previous articles given some account of this programme, but its principal features may thus be summarized: (a) the expansion of naval and military armaments; (b) the establishment of an Imperial University at Kioto; (c) the improvement of rivers for purposes of navigation; (d) the colonization of the Hokkaido; (e) the improvement of railway lines and the extension of the telegraph and telephone service; (f) the establishment of experimental farms and of institutes for training in all branches of the silk industry; (g) the encouragement of foreign trade; and (h) the establishment of a government iron foundry. This programme can be divided into two parts: one warlike, the other unwarlike; or, to take another classification, one unproductive and the other productive. The "warlike" part of the programme (including the iron foundry) was to absorb 142,000,000 yen; the unwarlike, 52,000,000 yen. In terms of sterling, the whole amounted to about £19,500,000. There was, however, to be a considerable addition to the ordinary expenditure, so that the total expenditure (extending over a period of six years) which belongs to what is known as the "First Period Expansion Programme" is about £25,000,000. In 1897-8 there was initiated the "Second Period Expansion Programme," which was a sequence to the first, and included works to be carried on in continuance of those under the first period programme, such as the construction of coast batteries, the building of barracks, the manufacture of arms, the making up of deficits in the funds set apart for the use of firearms factories and a woolen cloth factory for the production of materials for the clothes of the soldiers and sailors. The second programme required 38,358,594 yen for military and 118,324,718 yen for naval expenditure. Some of the items, however, have turned out greater than was estimated, and it is probably not overstating Japan's expenditure for her army and navy expansion, consequent upon, and subsequent to, the war with China, at 400,000,000 yen, or £40,000,000. Both the programmes have been practically carried out, and by the spending of the money Japan is now in the possession of an army and navy of which she is proud, and may well be proud. There can be no doubt that it is the possession of these, and not simply the progress which she has made in commerce and industry, that has induced the Powers to admit her into the comity of nations. The action of Russia, France and Germany taught her a lesson she is not likely to forget. She saw that unless she could make herself sufficiently strong to be respected, she would be coerced by the Powers, and she resolved to strengthen herself; the wisdom of which no one will doubt, provided she did not go beyond her means and place a heavy burden on her people.

As a matter of fact, however, the greater part of the extra expenditure has been paid for by China. The total amount of the indemnity paid by China was 365,529,067 yen, the greater part of which was used for the purpose of carrying out the naval and military expansion programmes. Moreover, the development of railways has led to a great expansion of trade and industry, and, therefore, to an increase of the taxpaying power of the country, and the amount of taxation per head of population is relatively small. Direct taxation amounts to about 83,000,000 yen, and as the population of the Japanese Empire (including Formosa) is probably nearly 50,000,000, the amount in proportion to population cannot be deemed excessive. Moreover, the system of taxation is being graduated, so that it presses lightly on the lower orders, the result being, as the Times correspondent declares, that at no period of their history have the masses been in such easy circumstances as they are at the present time. The national debt of the country stands at a little over £50,000,000 sterling, that is a trifle over £1 sterling per head, which is not a very great burden for a country like Japan. Against that debt it has valuable assets, not the least being the recognition of the proper position of Japan by the great Powers of the world.

At the same time it must be admitted that at the present time money is scarce and dear in Japan, and it is not to be wondered at. The Japanese have sunk a great part of their floating cash in enterprises, many of which are yielding good returns; others will not pay, either directly or indirectly, for a considerable time, but they were all necessary for the development of the country. The Japanese should give increased facilities for the employment of foreign capital in their country, and there can be little doubt that if care and judgment be exercised it would yield a good return. We commend the study of the details given in the publications we have mentioned to those who are interested in the subject.—Engineering.

THE USE OF KITES TO OBTAIN METEOROLOGICAL OBSERVATIONS.*

By A. LAWRENCE ROTCH, Director of Blue Hill Meteorological Observatory.

HISTORICAL researches, stimulated by the recent practical applications of kites, seem to show that their first use for scientific purposes was in 1749, when Dr. Alexander Wilson, of Glasgow, and his pupil, Thomas Melvill, lifted thermometers attached to kites into the clouds. These kites, from 4 to 7 feet high and covered with paper, were fastened one behind the other, each kite taking up as much line as could be supported, thereby allowing its companion to soar to an elevation proportionally higher. It is related that "the uppermost one ascended to an amazing height, disappearing at times among the white summer clouds, while all the rest, in a series, formed with it in the air below such a lofty scale, and that, too, affected by such regular and conspiring motions as at once changed a boyish pastime into a spectacle which greatly interested every beholder. . . . To obtain the information they wanted, they contrived that thermometers, properly secured and having bushy tassels of paper tied to them, should be let fall at stated periods from some of the higher kites, which was accomplished by the gradual singeing of a match line." Since the minimum thermometer had not then been invented it is difficult to understand how the thermometers were prevented from changing their readings while falling to the ground. The account concludes: "When engaged in these experiments, though now and then they communicated immediately with the clouds, yet, as this happened always in fine weather, no symptoms whatever of an electrical nature came under their observation. The sublime analysis of the thunderbolt and of the electricity of the atmosphere lay yet entirely undiscovered, and was reserved two years longer for the sagacity of the celebrated Dr. Franklin." Hence it seems that Franklin's famous experiment of collecting the electricity of a thundercloud by means of a kite, performed at Philadelphia in 1752, was not the first scientific application of the kite, and therefore America can claim only the later and most remarkable development of this means of exploring the air. About 1837 there existed in Philadelphia an organization called the Franklin Kite Club, that flew kites for recreation. Espy, the eminent meteorologist, was a member, and he states that "on those days when columnar clouds form rapidly and numerously the kite was frequently carried upward nearly perpendicularly by columns of ascending air," a phenomenon which is often observed to-day. Espy calculated the height at which clouds should form by the cooling of the air to its dew point, and then employed kites to verify his calculations of the heights of the clouds. Both these methods were utilized in the measurements of cloud heights at Blue Hill.

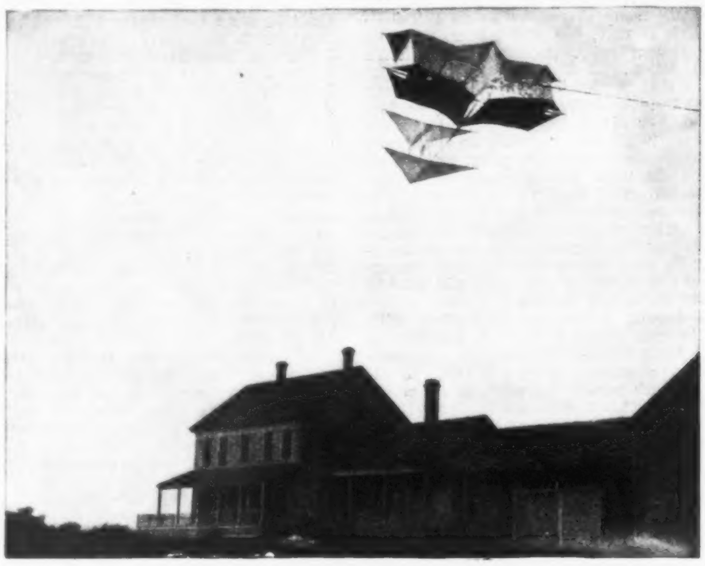


FIG. 3.—LAMSON'S AERO-CURVE KITE.

Kites were employed to get temperatures a hundred feet or more above the Arctic Ocean early in the present century, and in 1847 Mr. W. R. Birt, at the Kew Observatory in England, flew a kite for the purpose of measuring temperature, humidity, wind velocity, etc. His kite, of hexagonal shape, required three strings attached to the ground to keep it steady, and while he proposed to hoist the instruments up to the kite by means of a pulley, it does not appear that this was done or that any observations were obtained. In 1882 Mr. Douglas Archibald, in England, revived the use of kites for meteorological observations and outlined a comprehensive scheme of exploring the air with kites, which included almost all that has been done since. His actual work, performed during the next three years, was limited to ascertaining the increase of wind velocity with height up to 1,200 feet, and to do this he attached registering anemometers at four different points on the kite wire; but since the total wind movements only were registered from the time the anemometers left the ground until they returned, it was impossible to obtain simultaneous records near the ground and at the kite, as is done to-day. Mr. Archibald in 1887 took the first photograph from a kite, a method which MM. Batut and Wenz developed in France, and Messrs. Eddy and Woglom in the United States.

The subsequent progress of kite flying for meteorological purposes was in this country, and it may be chronologically stated as follows: In 1885 Mr. Alexander McAdie (now of the United States Weather Bureau) repeated Franklin's kite experiment on Blue Hill, with the addition of an electrometer; in 1891 and 1892 he measured simultaneously the electrical potential at the base of Blue Hill, on the hill, and with kites as collectors several hundred feet above the hilltop, about the same time that Dr. Weber, in Breslau, Germany, was making a more extensive use of kites for the same purpose. It was no doubt William A. Eddy, of Bayonne, N. J., who turned the attention of American scientific men to kite flying, and created the widespread interest in kites which exists to-day. About 1890 Mr. Eddy lifted thermometers with an ordinary kite, but soon afterward devised a tailless kite resembling the one used in Java, except that the horizontal crosspiece is nearer the top of the vertical stick, and its ends are bent backward in a bow and connected by a cord. The next year, with several of these kites flown tandem, he lifted a mini-

FIG. 1.—EVOLUTION OF THE KITE-REEL.

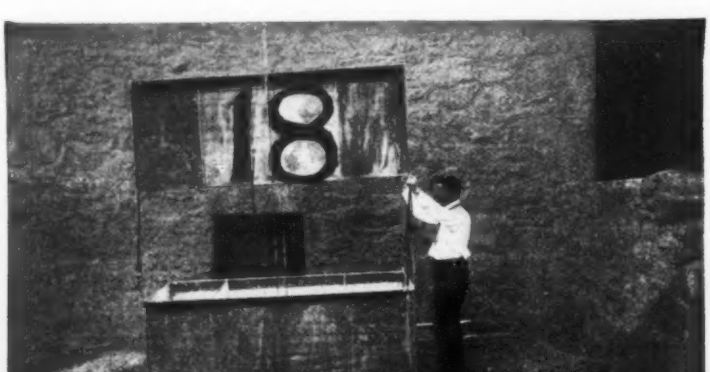


FIG. 2.—MODIFIED HARGRAVES KITE.

* Reprinted (with author's revision) from Technology Quarterly and Proceedings of the Society of Arts, Boston, June, 1900.—From the Annual Report of the Smithsonian Institution for 1900.

mum thermometer and proposed to obtain in this way data to forecast the weather.

Up to this time it does not appear that self-recording instruments—that is to say, those which make continuous graphic records—had been raised by kites. In the days of the early experimenters such instruments were too heavy and cumbersome to be lifted by the more or less unmanageable kites, but within the past few years M. Richard, of Paris, has made recording instruments sufficiently simple and light to be attached to kites. In this way it is possible to obtain simultaneous records at the kite and at a station on the ground, and from them to study the differences of temperature and humidity, and this seems to have

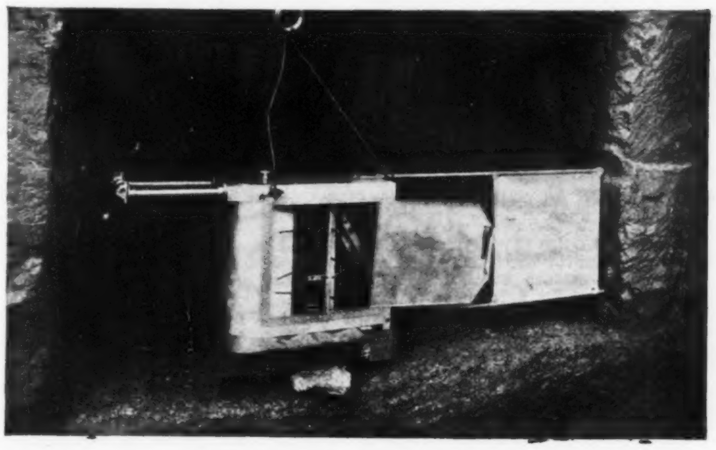


FIG. 4.—FERGUSSON'S KITE-METEOROGRAPH.

been done first at Blue Hill Observatory. In August, 1894, Mr. Eddy brought his kites to Blue Hill, and with them lifted a Richard thermograph which had been partly reconstructed of aluminium by Mr. Fergusson, of the observatory, so that it weighed but 2¼ pounds, to the height of 1,400 feet, and here the earliest automatic record of temperature was obtained by a kite. During the next summer Mr. Eddy secured photographs of the observatory and hill by a camera carried between his kites to the height of a hundred feet or more. Now that the possibility of lifting self-recording meteorological instruments to considerable heights had been demonstrated, an investigation of the thermal and hygrometric conditions of the free air was undertaken by the staff of the Blue Hill Observatory, who had already made an investigation of the currents of air at various heights by measurements of the clouds.

In the early experiments the Eddy or Malay kites, as they are also called, covered with paper or with varnished cloth and coupled tandem to secure greater safety and lifting power, were used. The kites were attached at several points on the line, for although it can be demonstrated theoretically that a greater height is possible by concentrating all the pull at the end of the line, yet in the actual case of a line which is not infinitely strong the best results are got by distributing the pull, and in this way, too, kites can be added as the wind conditions aloft permit. The Eddy kite flew at a high angle above the horizon and through a considerable range of wind velocity, but it could not be kept permanently in balance or made to adjust itself to great variations in wind velocity, and therefore it was discarded.

The first meteorograph, being a combined recording thermometer and barometer (from which the height can be obtained), was constructed by Mr. Fergusson in August, 1895, and three months later he joined a recording anemometer to the thermometer, which was probably the first apparatus of this kind to be attached to kites. Subsequently there was used the meteorograph, recording atmospheric pressure, air temperature, and relative humidity, designed by M. Richard, of Paris, for use in balloons, but now for the first time made of aluminium. In August, 1895, in addition to the Eddy kites, there was tried the cellular, or box kite, invented by Lawrence Hargraves, of Sydney, Australia, which bears no resemblance to the conventional forms of kites, but consists of two light boxes without tops or bottoms, fastened some distance above each other. The wind exerts its lifting force chiefly upon the front and rear sides of the upper box, the lower box, which inclines to the rear and so receives less pressure, preserving the balance, while the ends of the boxes being in line with the wind keep the kite steady, and serve the purpose of the dihedral angle in the Malay kite.

On account of the weight of the large cord necessary to control these kites and the surface which is presented to the wind, a height of 2,000 feet above Blue Hill could not be reached; so, during the winter of 1895-96, following Archibald's example and the methods of deep-sea sounding employed by Capt. Sigsbee, United States navy, steel pianoforte wire was substituted for the cord. This wire is less than half as heavy and less than one-fourth the size of cord having the same strength; and, moreover, its surface is polished, which reduces the friction of the wind blowing past it. With the wire the height of a mile was reached in July, and a mile and two-thirds in October, 1896. Up to this time a reel turned by two men sufficed to draw down the kites, but the increasing pull and length of wire made recourse to steam power necessary. In January, 1897, a grant of money was allotted from the Hodgkins fund of the Smithsonian Institution for the purpose of obtaining meteorological records at heights exceeding 10,000 feet, and no doubt the first application of steam to kite-flying was the winch built by Mr. Fergusson, with ingenious devices for distributing, oiling, and measuring the length of wire. The cumulative pressure of the successive coils of wire finally crushed the drum, and the next apparatus applied the principle of Sir William Thomson's deep-sea sounding apparatus, in which there is no accumulation of pressure. In October, 1897, records were brought down from 11,000 feet, or 1,000 feet above the prescribed height. The kite reel, in its various stages of development, is shown in Fig. 1.

The kites and apparatus at present employed at Blue Hill will now be described:

The kites are mostly of Hargraves' construction with two rectangular cells covered with cloth or silk, except at their tops and bottoms, and one is secured above the other by four or more sticks. The wooden frames are as light as possible, but are made rigid by guys of steel wire which bind them in all directions. The average weight is about 2 ounces a square foot of lifting surface, which is about the same weight a square foot as the Eddy kites, when all the surface is included in the estimate. The largest of the Hargraves kites stands 9 feet high, weighs 11 pounds, and contains 90 square feet of lifting surface, which in the recent kites is arched, resembling the curvature of a bird's wings (Fig. 2). These curved surfaces increase the lift, or upward pull, more than the drift or motion to leeward, and so the angular elevation is augmented without materially adding to the total pull on the wire, which should not exceed one-half its breaking strength. Another efficient form that has been used at Blue Hill is the "aero-curve kite," made by Mr. C. H. Lamson, of Portland, Me., and shown in Fig. 3. In flight it resembles a soaring bird, and when not in use it can be taken apart and folded up. Mr. Lamson has recently constructed a similar kite, with three superposed surfaces, that has been the leader in some of the highest flights.

A most important factor in the success of the Blue Hill work was the application by Mr. Clayton, of the observatory, to every kite of an elastic cord inserted in the lower part of the bridle to which the flying line is attached; when the wind pressure increases this stretches and causes the kite to diminish its angle of incidence to the wind until the gust subsides. A kite can be set to pull only a fixed amount in the strongest wind, when the kite will fly nearly horizontal. We are therefore able to calculate the greatest pull that can be exerted on the wire by all the kites, and with this device the kites have flown through gales of 50 or 60 miles an hour without breaking loose or injuring themselves. In general, the angle of the flying lines of the Blue Hill kites is 50 deg. or 60 deg. above the horizon, and in winds of 20 miles an hour the pull on the line is about 1 pound for each square foot of lifting surface in the kite. Kites can be raised in a wind that blows more than 12 miles an hour at the ground, and as the average velocity of the wind for the year on Blue Hill is 18 miles an hour, there are few days when kites cannot be flown. In order to fly in the feeblest winds possible a small and light pilot kite has been used to help lift the large and heavier kite into the stronger and steadier wind that usually prevails a short distance above the ground.

The wire to which the kites are attached is steel music wire, 0.032 inch in diameter, weighing 15 pounds a mile, and capable of withstanding a pull of 300 pounds. The wire is spliced in lengths of more than a mile with the greatest care, special pains being taken that no sharp bends or rust spots occur which would cause it to break. To lift the increasing weight of wire, kites are attached at intervals of a few thousand feet by screwing on the wire aluminium clamps to which the kite lines are fastened, so that the angle may be maintained as high as is consistent with a safe pull. Since each kite adds to the strain upon the wire below it, latterly the lower portion of the main line has been composed of wire 0.038 inch in diameter that possesses a tensile strength of 390 pounds. The Richard meteorograph, contained in an aluminium cage of about a foot cube, weighs less than 3 pounds, and it is only necessary to screen the thermometer from the sun's rays to obtain the true temperature of the air, since the wind insures a circulation of air around the thermometer. Another meteorograph constructed by Mr. Fergusson records the velocity of the wind on the same drum with the three other elements, and weighs no more than the French instrument. It is shown in Fig. 4, and Fig. 5 is a facsimile record, two-thirds actual size.

The reeling apparatus is an example of how the same apparatus may serve diametrically opposite purposes. In sounding the depths of the ocean the wire must be pulled upward, whereas in sounding the heights of the atmosphere the wire must be pulled in the reverse direction. Therefore the deep-sea sounding apparatus has been altered by Mr. Fergusson to pull obliquely downward, the wire passing over a swiveling pulley, which follows its direction and registers on a dial the exact length unreeled. Next the wire bears against a pulley carried by a strong spiral spring, by which the pull upon it at all times is recorded on a paper-covered drum turned by clockwork, then it passes several times around a strain pulley, and finally is coiled under slight tension upon a large storage drum. When the kites are to be pulled down, the strain pulley is connected with a 2 horse power steam engine, and the wire is drawn in at a speed of from 3 to 6 miles an hour, but when the kites are rising the belt is removed and the pull of the kites unreels the wire.

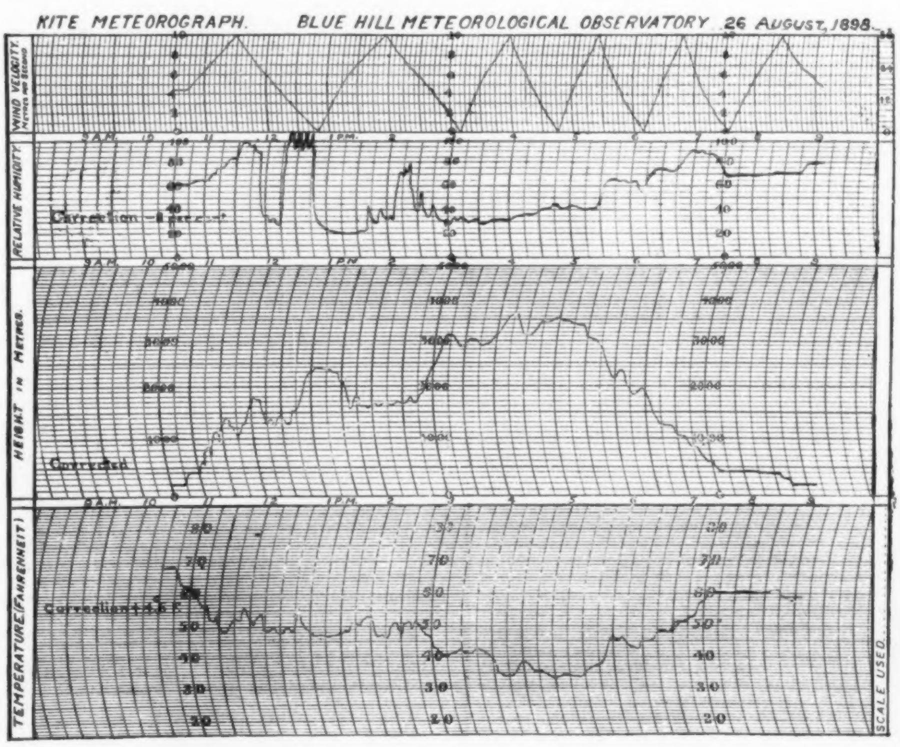


FIG. 5.—METEOROGRAM OF A HIGH KITE-FLIGHT.

The method of making a kite flight for meteorological purposes at Blue Hill is as follows. A kite, fastened to a ring at the end of the main wire, and the meteorograph clamped to the wire being in the air, another kite is attached by a cord and the clamp described. The kites are then allowed to rise and to unreel the wire until its angle above the horizon becomes low, when other kites are added, the number depending on the size of the kites and the strength of the wind. After a pause at the highest attainable altitude, the reel is connected with the steam engine and the kites are drawn down. The pauses at the highest point, and when kites are attached or detached, are necessary to allow the recording instruments to acquire the conditions of the surrounding air, and because at these times the meteorograph is nearly sta-

tionary, measurements of its angular elevations are made with a surveyor's transit, while observations of azimuth give the direction of the wind at the different heights. The time of making each angular measurement is noted, so that the corresponding point on the trace of the meteorograph may be found. From the length of wire and its angular elevation the height of the meteorograph can be calculated, it having been found that the sag of the wire, or its deviation either in a vertical or a horizontal plane from the straight line joining kite and reel, does not cause an error exceeding 3 per cent in the height so computed. When the meteorograph is hidden by clouds, the height above the last point trigonometrically determined is computed from the barometric record by Laplace's formula. At night there is only the barometer from which to determine the height, for, although an attempt was made to use a lantern to sight upon, yet it soon becomes invisible, or, when seen, is confounded with the stars. Before and after the flight the thermometer and hygrometer of the meteorograph are compared with the standard instruments.

Since the use of wire and more efficient kites the heights have been greatly increased. Thus the average height above the sea attained by the meteorograph in the thirty-five flights made during 1898 was more than a mile and a third, whereas the average height of all the ascents prior to 1897 was less than half a mile. The extreme height of 15,807 feet, reached in July, 1900, exceeds the altitude of Mont Blanc, and also the greatest height at which meteorological observations have been made with a balloon in the United States.

The average of the highest points recorded in each one of the flights during August, 1898, exceeded a mile and a half, and on August 26 the meteorograph was raised 11,440 feet above Blue Hill, or 12,070 feet above the neighboring ocean. The meteorograph was suspended from the topmost kite, one of the Lamson pattern, having 71 square feet of lifting surface, and this was increased to a total of 149 square feet by four kites of the modified Hargraves type that were attached at intervals to the wire. The 5 miles of wire in the air weighed 75 pounds, and the total weight lifted, including kites and apparatus, was 112 pounds. The meteorograph left the ground at 10:40 A. M., attained its greatest height at 4:15 P. M., and returned to the ground at 8:10 P. M., its automatic record being shown in Fig. 5, in which the heights are expressed in meters and the wind velocities in meters per second. The cumulus clouds were traversed three-quarters of a mile from the earth, and above them the air was found to be very dry. On the hill the air temperature was 72 deg., when it was 38 deg. in the free air 11,440 feet above, and the wind velocity increased from 22 to 40 miles an hour, as can be computed from the scale of miles on the right-hand margin of the anemometer record.

During the past six years, about two hundred and forty records have been obtained at Blue Hill in all kinds of weather conditions, from the ground up to 15,000 feet above it. They are published and discussed in the Annals of the Astronomical Observatory of Harvard College, Vol. xlii, Part I, and in several Bulletins of the Blue Hill Observatory, and constitute, no doubt, the most thorough study of the lower air yet made at a single station. The vertical distribution of temperature and humidity has been investigated and six types have been deduced. Normally, in fine weather, with increase of height the temperature decreases at the adiabatic rate for unsaturated air (1 deg. F. for 183 feet) up to a certain height where there is a sudden rise of temperature, and above that height the decrease is slower. This rise, which is caused by a warm current overflowing a colder one, is noted by aeronauts also at greater heights. Owing to the chilling of the air near the ground at night it frequently happens that it is warmer at the height of a thousand feet than it is at the ground, and as the relative humidity aloft is generally the reverse of what it is at the ground, it follows that at certain heights in the free atmosphere the nights are warm and dry while the days are cold and damp. Contrary to the observations on mountains, the diurnal period of temperature usually disappears above a mile, but the changes due to cold and warm waves occur simultaneously at the ground and at the extreme heights reached by the kites. The observations obtained during the passage of cyclones and anti-cyclones indicate that the cause of the cyclone, at least in our latitude, is its higher temperature with respect to the surrounding air. This conclusion agrees with the convectional theory of Espy and Ferrel, but it is possible that the shallow cyclones felt at the earth's surface may have superposed on them other cyclones with cold centers.

Atmospheric electricity is noticeable since the use of wire as a flying line whenever the kites rise higher than a quarter of a mile above the ground. Usually the wire becomes strongly charged with electricity when great heights are reached and this is discharged in bright sparks at the reel. The potential generally increases with altitudes, and probably the electricity is sometimes positive and sometimes negative, although no measurements have been made with the kites very high. Notwithstanding its intensity the quantity of electricity in the atmosphere appears insufficient to warrant its collection and storage for practical purposes.

During the summer of 1898 the United States Weather Bureau undertook to obtain daily from seventeen stations equipped with kites (situated chiefly in the Mississippi Valley), automatic records at a height of about a mile, with which to draw a synoptic chart of the upper air for forecasting in connection with a similar chart of surface observations. The high-level chart could not be drawn regularly on account of light winds at some stations, but much data concerning temperature gradients were obtained, and these have been published. Since the work at Blue Hill was made known to foreign meteorologists, who have received drawings and models of our apparatus, the use of kites to obtain meteorological data has been taken up extensively on the continent of Europe, and already the meteorological bureaus of France, Germany, and Russia have established departments for the purpose of obtaining observations in the free air with both kites and balloons.

Whenever there is wind, kites possess advantages over any other method of exploring the air up to the height of at least 15,000 feet. Although only on mountains can observations at a uniform height be maintained continuously, yet the conditions there are not those of the free air at an equal height. Observations in a drifting balloon are affected by the heated or stagnant air accompanying the balloon, and the progressive changes in the atmospheric conditions at one place can not be studied, because, generally, these observations are not comparable with simultaneous observations made at one station on the ground. With kites, however, frequent ascents and descents permit the true conditions prevailing in superposed strata of air at definitely known heights to be obtained nearly simultaneously. Kites can rise much higher than captive balloons, which are borne down by the weight of the cable necessary to control them. Finally, kites cost very much less than either mountain stations or balloons. It appears, therefore, that in future the equipment of a first-class meteorological observatory should include the kite (and perhaps the German kite-balloon for use when the wind is lacking), so that automatic records may be obtained daily at the height of a mile or two in the free air, at the same time that similar observations are made at the ground.

EDUCATIONAL SCIENCE AT THE BRITISH ASSOCIATION.

Though the new Section of the British Association was only appointed for a year, the success of the meetings at Glasgow was of so decided a character that the section will probably become a permanent part of the association. It can scarcely be said at present that an educational science exists, but the statement of methods and results, and the discussion of the relationships between principles and practice, apart from all political considerations, should do something to organize the conclusions of people who have given serious attention to educational problems. The section will exert the greatest influence in connection with scientific studies; and there is no reason why it should not lead to improvements in methods of teaching as valuable as those which have been produced by the scheme for a course of work in chemistry, drawn up by Dr. H. E. Armstrong for the British Association Committee on the methods of teaching chemistry. It is not too much to say that this scheme started a revolution which gathers strength every day. The system of science instruction by didactic methods still exists in places, but only because the machinery for carrying on the work on more rational principles has not been obtained. Wherever the object is education, the methods of research have been introduced, and it is recognized that real scientific knowledge can only be gained by individual experience.

EDUCATIONAL EXPERIMENT AND RESEARCH.

Sir John Gorst accepted the principle of research in education in his address as president of the section, and Dr. Armstrong emphasized it in an early paper. The power of research, the art of acquiring information for one's self, must, he pointed out, be cultivated in all because it is the power on which advance in life depends. The chief work of the section will be to teach this doctrine, and impress it upon the teachers. A science of education must be shaped, and a national programme must be constructed in which research methods are encouraged and teachers are trained to have sympathy with them. The humanists must enter into an alliance with the naturalists, and the union should take place on equal terms. At present our educational system is entirely one-sided. The schools still at best suffer science; they do not love it and the old universities do not even regard it as a necessary element of culture.

Reform will be brought about by the development of workshop and laboratory methods. The experimental method of teaching is adapted to the curiosity and activity of the average boy, and should be the basis of instruction at the earliest stages. Prof. L. C. Miall gave strong support to the experimental method, which he described as the most complete embodiment of the methodized art of trying, of ignoring failures and improving successes, and perpetually going on until the goal was reached. This is the habit it is desired to set up and which will take an important place in future educational work. Sir Michael Foster emphasized the view that science is not learned in the lecture room, but in the laboratory. The first aim should be to teach a boy to think, and this can be done by practical work properly arranged. It has been stated over and over again that pupils who have been prepared by the older learning take to science more readily when they are brought to it than those who have been trained from the very beginning in science. This, Sir Michael said, was easy to understand, because teachers in the humanities have been trained to teach for generations, while men of science are only now beginning to learn how to teach.

Methods of teaching are of great importance, and the British Association can be the means of producing improvements in them. Prof. H. L. Withers, however, in a paper on the scope of educational science, expressed the opinion that before deciding how this or that subject should be taught it is desirable to formulate a theory of the curriculum, that is, to arrive at some conclusion as to the proportional value of subjects. Mr. P. A. Barnett also took this view, the main argument of his paper being that the criterion of success in education must be, not what people have been taught to do or to make, but what they are and how they bear themselves in all the relationships of life. But the educational value of a subject even considered from this point of view depends upon the scope of the subject and the methods of teaching, so that a reasonable curriculum cannot be drawn up until a decision has been arrived at as to what is implied by the name of each subject.

As instances of differences of opinion as to what should be included in a subject and how the subject should be taught, the discussions on the teaching of elementary mathematics and of botany may be cited. In each case a whole morning was devoted to the expression of expert opinion and the statement of experience in relation to the subject under discussion. For the discussion of the former subject, a joint meeting was arranged with the mathematical department of Section A, and for the latter a joint meeting was held with the Section of Botany.

THE TEACHING OF MATHEMATICS.

In urging a reform of mathematical teaching, Prof. Perry remarked that he would teach mathematics—at all events advanced mathematics—in different ways to different students. In any case he thought the system of teaching boys elementary mathematics as if they were all going to be pure mathematicians must be altered. We taught all boys what is called mathematical philosophy that we might catch in our net the one demigod, the pure mathematician, and we did our best to ruin all the others. In his experience there was scarcely any man who might not become an advancer of knowledge, and the earlier the age at which you gave him the chances of exercising his individuality the better. Educate through the experience already possessed by a boy; look at things from his point of view—that is, lead him to educate himself. Through his whole mathematical course let him be taught through his own experiments, and do not call it waste of time to plot the stream lines, for example, after the algebraic academic answer of a problem has been arrived at. The unpractical nature of mathematical teaching, he held, caused men to leave common sense out of their teaching, and he instanced the great continental polytechnics, where an elaborate course of many months, or a year, was often devoted to a subject, of which the general principles could be grasped in a practical course of a few weeks.

All advocates of orthodox methods seemed willing to sacrifice every form of usefulness of mathematics to the mind-training inherent in a perfect logical system—a huge complex deduced logically from simple fundamental truths. Where would be the harm in letting a boy accept the truth of many propositions of the first four books of Euclid, partly by faith, partly by trial; of giving him the whole fifth book by simple algebra; and in letting him assume the sixth book as axiomatic? He would allow him, in fact, to begin his severer studies where he was now in the habit of leaving off; and would let him put aside much more than is usually done, so that he would get quickly to the solution of partial differential equations and other useful parts of mathematics. He had been speaking of the training of the mathematician, and he might be wrong; but as to the educational training of the man who was to use his mathematics in the study of pure and applied physical science, he had no doubt whatever of the importance of skipping judiciously in all early mathematic work. In these days all men ought to study natural science, and in such study they required to have the knowledge of algebraic formulæ and the power to use them; to be familiar with the use of logarithms in computation; with the use of squared paper, and with the methods of the calculus. He held that dexterity in these is learned by quite young boys, and he felt sure that such dexterity could not hinder, and could only further, the mathematical study of the exceptionally clever student.

Mathematics was a powerful weapon to unlock the mysteries of nature. If a man knew how to use the method, that would be enough; he could leave to others, who delight in that, the forging and complete study of the weapon. The average young engineer might be made to possess a power of using the methods of mathematics, which would be as easy to him as reading or writing or using any hand tool—a power which would never grow rusty, because it would be exercised every day of his life; and his present hatred of mathematics and theory of engineering was leading to disaster. Higher mathematics had become a very useful thing. As in the case of all other generally useful things, the complete study of its philosophy in the orthodox manner was not a necessary part of the school or college curriculum. In concluding his remarks, Prof. Perry defended himself against the charge which his engineering friends had brought against him, that he had an exaggerated notion of the importance to all men of possessing a love of mathematics.

The discussion upon the paper was commenced by Prof. Hudson. He said that a too common fault in teaching mathematics consisted in allowing the pupil to learn by heart propositions, formulæ and rules, instead of using them as a means of training the reasoning powers. He trusted that Prof. Perry did not really wish to recommend that method, but he was afraid that its advocates might quote Prof. Perry in their support. Elementary teaching should be so conducted as to prepare for more advanced teaching; nothing should have to be unlearned. Geometry should be based on the observation and handling of models of solid figures, and thus could be begun at a much earlier age than was generally supposed. Prof. Forsyth criticised the vehemence of the attack which Prof. Perry had made upon the mathematician while sympathizing to a considerable extent with his aims. He pointed out that subjects do not necessarily progress on the lines of direct usefulness, and that very many of the applications of the theories of pure mathematics had come many years—sometimes centuries—after the discoveries themselves; the weapon had lain ready to hand, but the man had not been there to use it. He also indicated briefly his views on the teaching of elementary mathematics, and advocated the inclusion of a course on practical geometry early in the pupil's career. With this suggestion, that the pupil should be led to pure geometry only after he had been accustomed to handle and to work with the figures with which geometry is concerned, all the subsequent speakers cordially agreed. Prof. Forsyth further desired to point out the need of a proper system of training teachers so that when they began their profession they would not have to devote their time to practising upon their earliest pupils the method that happened to suit their own particular temperament. Major MacMahon—the president of Section A—joined in the discussion, but confined his remarks to the subject of elementary teaching without entering upon the more important questions raised by the address, which he had already dealt with in his opening address to the section. Prof. Rücker said that there seemed to be a general agreement among all the speakers that, in the case at all events of the younger children, the teacher ought to approach the subject as

far as possible from the concrete side. He also held, with Prof. Perry, that a somewhat rapid advance was advisable in the first case, the various qualifications with which the general statements had to be guarded being entered upon later. While not attacking the system of examinations—which had come in for severe criticism by other speakers—he considered that it had its weak points, but that it was a necessary part of our educational apparatus. Prof. Silvanus Thompson and Prof. Henrici were in entire accord with Prof. Perry; and the latter expressed the hope that qualified mathematicians would prepare textbooks upon the lines laid down in the address. Prof. Everett pointed out the need of distinguishing between technical and liberal education, and Prof. Miall criticised the system in which the needs of the pupil and teacher were sacrificed to the demands of the examiner and inspector. Mrs. W. N. Shaw spoke upon the bearing of the discussion on the education of girls; and there also joined in the debate Mr. J. Parker Smith, M.P., Prof. Greenhill, Prof. Alfred Lodge, Prof. Minchin, Mr. E. M. Langley and others.

An immediate result of Prof. Perry's address has been the appointment of an influential committee of the association, with Prof. Forsyth as president and Prof. Perry as secretary, to report upon improvements that might be effected in the teaching of mathematics.

THE TEACHING OF BOTANY.

The joint discussion on the teaching of botany was held in the rooms of Section K, Prof. Bayley Balfour being in the chair. Mr. Harold Wager introduced the discussion by reading a paper on the teaching of botany in schools. He said that more attention should be paid to methods of teaching if the subject was to take its proper place in the school curriculum as a part of the general scientific training. Too much time should not be spent in mere descriptive work; and the use of the compound microscope should not be encouraged. The right selection of topics was important. Such subjects as experimental plant physiology, the structure and germination of seeds, and the structure and function of the flower were specially to be commended. A good grip of fundamental principles and not an imperfect acquaintance with a vast number of facts was wanted in school teaching.

Prof. Bower read a paper on the teaching of botany in universities. He also urged that the use of the microscope in schools should not be allowed. It should be left to the university course. Thoroughness in special branches should be aimed at with advanced students, not encyclopedic knowledge. Method was far more important than mere information. Advanced students should be left to work independently as much as possible. Research should be encouraged, but futile investigations were a mistake. Stress should be laid upon writing up the results of any piece of work in good literary form.

In the subsequent discussion Prof. Miall said that in his elementary teaching at the Yorkshire College the laboratory work was the most important part of the work. Lectures were not given, but after a period in the laboratory a discussion on the facts observed took place in the lecture room, and the students were expected themselves to give an account of their work. They very soon learned to express themselves clearly and easily, and had little difficulty in passing examinations. Prof. Marshall Ward agreed that observations formed a very important part of elementary botany, and children could be taught to reason from facts observed. With advanced students research was a powerful stimulus in developing interest in the subject. Prof. Withers believed that the study of science might well begin with natural history. Chemistry and physics should then be taken, and such a subject as botany might again be taken up in the higher forms. But as a training in scientific method he thought the value of botany was often extremely small.

Prof. Armstrong considered that more attention might be given to systematic botany, and science altogether should be taken more seriously in schools, and at least half the school time should be given to practical work. Chemistry and physics, as well as botany, were required in order to give the student a good knowledge of scientific method. Dr. D. H. Scott said that there was often too much specialization in the syllabuses drawn up for elementary classes. His experience as an examiner had shown him that the subject could be easily crammed without developing any real knowledge of the subject. Dr. Kimmins gave the opinion, as the result of his experience, that botany was often very badly taught in schools because of the want of properly trained teachers. He thought it was a pity that there was a tendency to replace it altogether by physics and chemistry.

Sir John Gorst said that it seemed to him that one of the best science subjects for purposes of general education was botany, especially for rural schools. The provision of laboratories and apparatus was a difficulty. Perhaps the County Councils might help with these. Properly trained teachers were required, and the subject should have attention in training colleges. Too many rural teachers at the present time were not properly qualified to give simple lessons in botany.

The chairman in closing the discussion said that it had been of great interest, and he felt that improvement would take place as soon as a good supply of properly trained teachers could be obtained.

ORGANIZATION AND ADMINISTRATION.

The other subjects dealt with in the section belong more to the organization and administrative side of education than to the aims, scope and methods of science teaching, so a brief mention of them will be sufficient in these columns. Sir Henry Roscoe introduced the subject of the organization of technical and secondary education, and in commenting upon it Sir Michael Foster said that whatever legislation was brought forward it was to be hoped that no distinction would be made between primary and secondary education. Sir Philip Magnus spoke in favor of the unification of educational effort by the creation of local authorities to be responsible for education in their areas. A paper by the Bishop of Hereford on the influence of the universities and examining bodies upon the work of schools contained a plea for the recognition of science and modern languages as substitutes for Greek in Responsions. It was pointed out that the existing requirement of Greek from every candidate desiring to enter the older universities, together with the accompanying exclusion of modern languages and science, practically dissociates the whole class of modern schools or modern departments in schools from direct university influence, and the effect is found to be specially unfortunate in the modern departments of the large secondary schools. The paper will be printed in full by the association. Among other subjects discussed were commercial education, and the mechanism of education in Scotland. Dr. J. H. Gladstone also read his annual report on the teaching of science in elementary schools, hitherto presented to the chemistry section, but there were few other papers, the system adopted in the arrangement of the programme being to accept only one or two papers for each meeting, and these to be on definite topics requiring discussion. By this means attention was concentrated upon particular aspects of educational work instead of being directed this way and that by a variety of papers. The system has worked so successfully that it will probably be followed at future meetings of the section.

THE JAVAL ACETYLENE GAS GENERATOR.

IN the construction of his acetylene gas generator, M. A. Javal has purposed to obtain the following results: (1) To assure the production of gas of the best quality possible in a strictly limited volume; (2) to render materially impossible any increase of pressure, any elevation of temperature, any return of acetylene, any re-entrance of air, and to give every guarantee against any accident whatever; and (3) to reduce the manipulations to a single one; that is to say, to the recharging of a distributer.

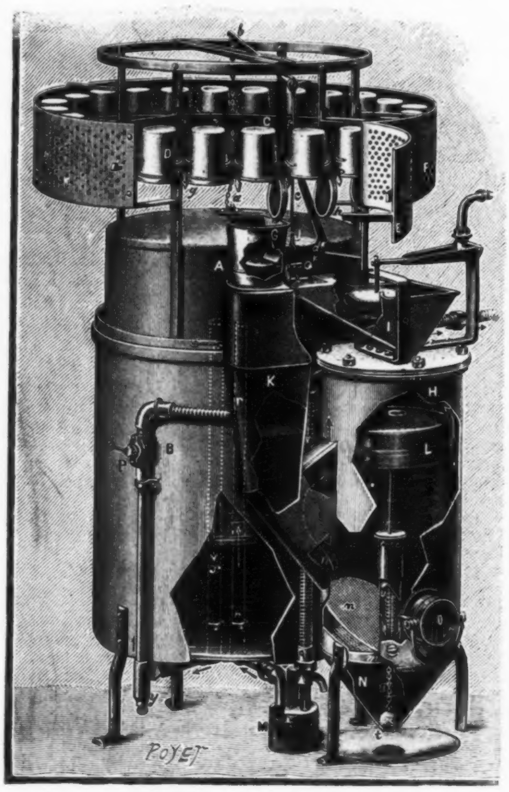


FIG. 1.—GENERAL VIEW OF THE JAVAL ACETYLENE GAS GENERATOR.

The apparatus (Fig. 1) consists essentially of a holder, *A*, placed in a water tank forming a gasometer. In measure as the acetylene is consumed the holder descends in the tank through its own weight. In this motion it pulls, through the chain, *a*, upon the lever, *b*, which, in turn, acts upon the distributer placed above the holder. This distributer consists of a ring upon the exterior of which are placed movable boxes, *D*, having the form of inverted metal cups. Each of these contains a charge of carbide limited by its capacity, and is provided with a movable cover that assures perfect tightness. This circle of boxes is surrounded with a perfected band, *F*, in the interior of which is fixed a stop, *h*. When the lever, *d*, comes into contact with one of the pins, *e*, fixed upon the ring, the latter moves forward upon its rollers. At the moment that a box comes over the pipe, *G*, the catch, *g*, meets with the stop, *h*, the box opens and the charge falls and lifts the pawl, *k*, and frees a rocking device, *I*, connected on the one hand with a water conduit, and on the other with a chute, *K*. The water then flows, and, in its fall, carries the carbide rapidly along to the grating, *m*, in the generator, *H*, where decomposition takes place almost instantaneously. The acetylene produced passes into the holder after having traversed the liquid in the direction shown by the arrows. The water of the rocker causes the ascent of a float, *L*, connected with a valve, *s*. This latter, under the action of the spring, *r*, suddenly opens and gives exit to the impurities resulting from the preceding operation.

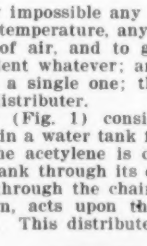


FIG. 2.—DETAILS OF THE COVER OF ONE OF THE CARBIDE BOXES.

It is very important to remark that the entire series of these latter motions is produced only by the fall of the carbide. Were a box empty through accident or inadvertence the rocker would not be set free.

On another hand, if we require too rapid a production from the apparatus the ascent of the holder will be insufficient to cause a new fall, and the apparatus will become inoperative.

Fig. 2 shows the details of the method of closing the boxes. Tightness is obtained by means of a rubber joint and a bar forming a spring attached to the center of the cover, an arrangement something like that found in the glass jars used for preserving fruit.—For the above particulars and the engravings we are indebted to La Nature.

THE ENAMELINE PROCESS—ETCHING ON ZINC

By W. T. M. DAVIDSON, of the L. C. C. School of Photo-engraving and Lithography.

MOST etchers, I presume, will do their own lining up and spotting, so that on receiving the plate an examination must be made for any defects such as dots missing owing to black specks in the negative or dust in the frame. To spot out these places take a No. 1 sable brush with an exceptionally good point. The brush used should be kept solely for this purpose. Finishing ink thinned with turps is the most convenient to work, as it does not dry so readily as bitumen or shellac varnish. Spot out with the aid of the magnifier, and try to make the dot the same size as the others. A daub means a lot of unnecessary engraving and in the case of one or two dots missing, it only requires a little patience and practice to so correctly copy the surrounding dots that the inserted ones are not noticed. If, after having spotted a plate, it becomes necessary to remove the work and do it again, the ink must be taken off perfectly clean with a tuft of cotton wool moistened with turps. Black patches on the metal caused by a hole in the negative can be rectified by imitating the surrounding screen with a needle-point.

For the lining up a good ruling pen is needed, and the best medium is made by thinning down Brunswick black with methylated spirit or bitumen in turps. Finishing ink can also be used if sufficiently thinned to run freely from the pen. How to get the side lines at right angles with the base is comparatively an easy matter. Some prefer a lining-up board, while others work with two set-squares. There is another method of putting a line round a block, and that is to cut with a sharp instrument, such as an engraver's tool, through the film of the negative. In cases where the glass is not going to be used again, this is the most effective, as a narrower line can be obtained in this way. To put a white line inside the black one requires a good deal more skill, and if there be an engraver in the establishment, it is best to leave that to him after the block is etched.

These operations having been performed, warm the plate to set the ink, and varnish the back with shellac dissolved in methylated spirit. The etching of half-tones is so slight that the varnishing may be omitted. In fact, there is very good reason for not doing it. With an earthenware etching trough, or even a pitched wooden one, if the plate slides about much during the etching, the varnish will, in parts, be scraped off, and consequently the plate etched. If this takes place to any extent the block will have to be underlaid in the printing to make up for it, therefore if the back be clean it is as well not to do the varnishing.

The etching of a zinc half-tone must be done in a trough at least twice the size of the largest plate it is proposed to etch.

The strength of the bath should be 1 in 40, i. e., one ounce of commercial nitric acid to the quart of water.

This bath will do for a half-plate. For larger sizes the bath must be increased according to the size of the plate. It is advisable to always etch with one strength, and 1 in 40 is found from experiment to be the best average strength. A fresh bath must be made up for each plate.

The solution must flow completely off each time the bath is rocked, and be allowed to run back rather vigorously, causing a wave to break on the metal. This is sufficient to remove the scum formed and ensure even etching. Keeping the plate covered with the solution stops the action.

No brushing of the plate is permissible after the first half minute in the bath, and whenever possible even that brushing should be dispensed with.

During the etching move the plate around two or three times. The wash will not then always strike one side of the dot.

Time of etching will, of course, be regulated chiefly by the screen ruling, and in a lesser degree by the temperature. Some idea of the depth to go can be obtained by carefully noting the breadth of the high-light dot before starting, and etching almost as deep as that dot is broad. This, it will be seen, gives a guide to any screen ruling. Etching to strict time cannot be done; but to give some idea of the duration of etching, I might mention that if the above instructions be carried out, zinc should etch in the following times:

175 line screen	4 to 6 minutes.
133 line screen	8 to 10 minutes.
120 line screen	10 to 12 minutes.

I give these times for a special reason, which I will point out later on.

The etching over, the plate is removed, rinsed under the tap, rubbed with a wash leather and dried. Brush the plate well to remove the loose enamel, and pull a proof.

From the above description the process seems simplicity itself, and as a matter of fact it is. Yet how

many workers fail completely when they try to do it. Most complaints originate from erroneous ideas as to the limits of the process. Is there any need to confess that enamel on zinc does not stand like enamel on copper? It is through supposing that it does that so many failures occur. If the enamel stands while the plate is being taken down full printing depth, that is as much as ought to be expected of it. Now and again enamel remains on the plate, after etching, as firm as a rock, and I will treat of that later on; but nearly always it will leave the plate after being subjected to a good etch. Having recognized that we are treating with a substance that gets softer and softer as the etching progresses, there is an important point which must be attended to. Except where it is unavoidable, never remove the plate from the bath and dab off to see how the etching is progressing. Having satisfied one's self that the image is perfect, come to some decision as regards time of etching, and let the plate have that straight away. If my rough times quoted above are followed, the plate at the end of that period will have attained full printing depth; consequently all fear of spoiling the block will have passed. Should it require another minute or two and the enamel has given way, the block can then be rolled up with a glazed roller charged with hard etching ink.

The whole secret of successful etching on zinc is to get the etching over in one go. No slow rocking with the head in the trough to watch the effect will do here. One bite straight away is the thing, and don't remove the plate for anything less than a hole forming in the resist.

When the enamel is giving out it assumes a spongy appearance. All the shininess it had at the beginning of the etch has disappeared. When rinsed under the tap, if the fingers be passed over the surface, the enamel will come away like a powder. When in this state the whole of it should be removed with caustic soda used on the hot plate. In nearly every case it will be found that the block is not affected.

For a demonstration suppose we are etching a 133-line screen. According to my instructions, precautions are taken against defects in the image, and the plate etched straight away for eight or ten minutes. The enamel after this will probably brush off when the plate is cleaned in the sink; but the surface of the metal should not be impaired. If it is, do not think the process is always going to give such results. There is something wrong, which is easily rectified and may be caused by either one or more of the following: Enamel too thin; light printing (which may mean enamel was too thick for that particular negative); under, over, or uneven burning; metal insufficiently cleaned.

Now the retention of the enamel on the metal is to be held up as a fetish, some slight modifications in the above method of working are necessary. The all important point in retaining the enamel is a prolonged exposure. The negative must therefore be made with that object in view. Next I find a tougher film is obtained when chromic acid is used in the glue. If my instructions are being followed for making glue more rapid, chromic acid can be substituted for chrome alum.

Lastly, the metal should be grained in a one per cent of nitric acid.

Why I have not previously advocated graining metal is, that what is gained in one place is lost in another. With the metal grained, the enamel will hold on a trifle better; but at the same time it is a prolific source of veil and scum. It does not require much thought to see that as the whole popularity of the enameline process is based on the fact that the developing is spontaneous, any thing which is likely to retard it is not to the advantage of the process. Naturally glue will wash out better on a polished surface than on a matt; so why grain, if the aim is to obtain the best possible results? There are many printers who grain zinc and yet would not think of graining copper. Surely what is good for one ought to be good for the other. To grain copper would be courting disaster from the effects of scum. Although the same scum on zinc will be penetrated by the acid, a great risk is being run, and certainly the work is not being improved. It is only in attempting to attain the object I am writing of, that it is advisable to grain.

So, then the facts are these:

The negative should be fairly well joined in the high-lights and the shadow dot in large proportion; requiring two or three times the ordinary exposure. The glue should be slightly thicker and containing preferably chromic acid; but this is not of vital importance. The metal can be grained in a one per cent of nitric acid. Nothing stronger should be used, as the film is liable to become sodden if on too rough a surface. After the prolonged exposure, if there should be slight traces of a veil, the film will be tough enough to stand gentle rubbing with cotton-wool.

One other point. Attention ought to be given to the depth to which a half tone block must be taken. The best and surest proof that the depth is sufficient is to take an ordinary composition roller charged with printing ink, and roll up the block with slight pressure. If the high-lights do not fill up and the block gives a clean impression, the depth is enough. If, on the other hand, the high-lights tend to fill in, the block must be taken deeper. To do this, take a glazed roller charged with what is known as finishing or re-biting ink as used for line work. Roll the plate up carefully free from hairs or dirt, and glaze on the hot plate until the ink just runs over the edge of the dot. When cool, whatever extra etching is required can be given. Further instructions for rolling up half-tones will be given later on in an article on fine etching—The Process Photogram; Process Review and Journal of Electrotyping.

Mouth Wash Tablets.—

Heliotropin	0.01 gramme.
Saccharine	0.01 gramme.
Salicylic acid	0.10 gramme.
Menthol	1.00 grammes.
Milk sugar	5.00 grammes.

Spirit scented with rose oil, as required.

Make 100 tablets. In order to give the mouth wash a nice color, the mass may be dyed red with eosin, green with chlorophyl and blue with indigo-carmine.—Pharmaceutische Zeitung.

THE TRUE CARTHAGE.

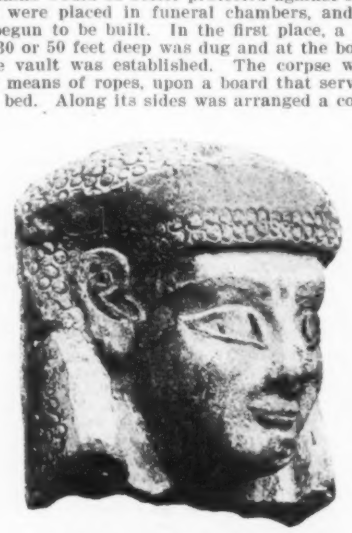
It is claimed that, long before our era, the Sidonians, wishing to compete with the Tyrian colony of Utica, founded a manufacturing settlement called Cambe at the back of the gulf of Carthage. Whether this is true or not cannot be ascertained. All that can be said is that the situation of the bay of Tunis is so favorable that the Phenicians must have settled there at a very early period. Some centuries later on, a revolution broke out at Tyre. In the year 814, the democratic party having become all powerful, the patricians tried to get into power again by force, but failed, and, in order to escape death, were obliged to take to the sea. They embarked at the place where Cambe stood. The chief of the troop was Elissar, a woman of royal blood, to whom was given the surname of *Dido*, that is to say "Fugitive." Received by the natives of the country, she purchased from them the right to settle therein, and founded upon the shore of the sea the "New City," *Karthhadach*, of which the

A GRINNING FUNERAL MASK.

CARTHAGINIAN MAGISTRATE.

Greeks made Carchêdon and the Romans Carthago, whence the modern name Carthage. In its broad lines, this tradition seems to agree with historical reality, and the first Carthaginian establishment of any importance was doubtless a Tyrian colony. Of this, investigations made upon the spot have permitted of tracing the limits. Around the gulf, and at some distance from the shore, extends in the form of an amphitheater, a succession of hills. The most easterly, now the hill of Saint Louis, formerly Byrsa, was the point occupied by Dido according to legend; but this is an error. The most westerly, upon which of old stood a small Turkish fort, immediately dominates the sea. All these hills contain burial places, the most ancient of which date back to the seventh century, while the most recent are not posterior to the Punic wars. Now, as we know, the dead were considered by the Semites as impure objects, and were never interred in the interior of cities. It must be admitted, then, that the primitive city did not extend beyond the series of hills that surrounded it. It was between the sea and the contiguous heights that Dido's companions established themselves, under the protection of a wall. The establishment gradually increased, and beyond it, some Africans, attracted thither by the great city, estab-

A MASK OF A MAN.



MASK OF A WOMAN.

lished their "gourbis," or their *magalia* as they were then called. True suburbs were established and surrounded the region of the necropolises. These were enveloped in turn by a second girdle, and it was in this state that the Romans found Carthage, and in which they described it. The fortifications that they represent to us as having been so powerful and gigantic have disappeared to the last stone.

Are we any better informed as to the ports that played so important a part in the whole history of the city? It has long been thought so, for writers have left us descriptions of them that appear to be quite accurate and all traces of them have not as yet disappeared. Since, according to tradition, the port of Carthage consisted of two parts, a commercial basin and a naval one, and since, in the center of the latter, there was a terre-plein supporting the admiral's palace, there has been no hesitation in recognizing the remains of the port of Carthage in the two present lakes situated opposite the hill of Byrsa, and in the center of one of which there is a small island. It appeared to result from the investigations of the officers of the French vessel "La Goulette" that the two lagoons situated to the south of Byrsa represent the naval port and that alone, while the commercial port extended to the front and was protected by strong jetties, parts of which remain buried in the sand at a short distance from the shore. But is this really the port of Carthage? Was it not reconstructed, enlarged and transformed by the Romans? No one is able to say; and so the problem remains and will doubtless remain without a formal solution.

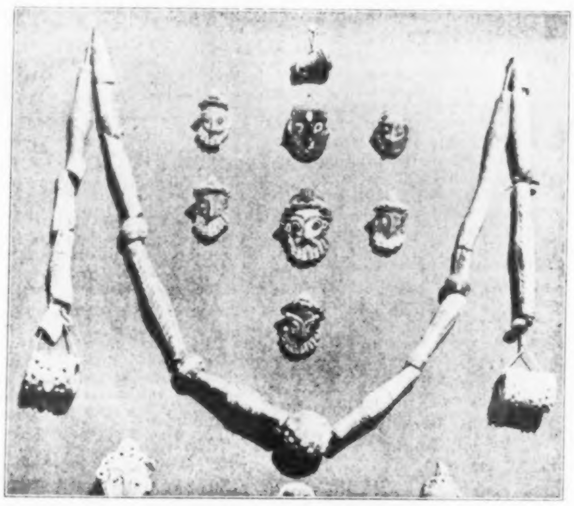
There is the same negative result for the streets and the houses. Certain maps of old indicated the site of Hannibal's house and Dido's palace. Would to heaven that we ourselves were as well informed. The truth is that scarcely anything remains of the Punic city. Nowhere, even upon Byrsa, where ten years ago shafts were sunk as far as to the rock for the construction of a cathedral, has there been found an important fragment that can be asserted to have belonged to it. The Carthage of Hannibal can be reached only in the imagination; it does not belong to erudition, but to romance.

We speak of the Carthage of the living, for that of the dead has not disappeared, but remains nearly intact under the earth that covered it. The generations that have succeeded each other, in adding their deposits, have merely buried it still deeper. It suffices to descend to the subsoil in order to find the contemporaries of Dido and the Punic wars lying in their last abode. They are distinguished from each other by the form of their graves and the nature of the objects scattered around them in the tomb. At the most remote epoch that we can reach the corpse was deposited in the sand with nothing to protect it. Then the idea occurred that the remains would be better protected against sacrilege if they were placed in funeral chambers, and so the latter begun to be built. In the first place, a vertical pit 25, 30 or 50 feet deep was dug and at the bottom of this the vault was established. The corpse was lowered by means of ropes, upon a board that served as a funeral bed. Along its sides was arranged a collection of pottery, domestic utensils, statuettes that had either a symbolical or religious signification, jewels that had been prized by the owner, and grinning masks to offer a protection against evil spirits. A silver lamp was lighted and then the chamber was closed and the pit filled up. If it be desired to know how rich the deposits in these vaults sometimes were, we have only to read what M. Gauckler says of one of these tombs that he opened in 1899. "The skeleton still held in its left hand a large bronze mirror, and in the right, heavy cymbals of the same metal. The left wrist disappeared under a bracelet of pearls. Upon the right arm were strung several silver and ivory rings. The fingers were loaded with silver rings and one of gold. From the left ear hung a golden pendent. Upon the neck there was a necklace of massive gold formed of forty elements of varied shape, symmetrically arranged, and of a central brooch of a turquoise crescent and a disk of hyacinth. The adornment was completed by an-

other silver necklace." Later on, the method of burial was slightly modified, the corpse being placed in a wooden coffin or stone sarcophagus. It was thus that the contemporaries of the Punic wars were buried. To this change there corresponded another. In the first place, the contents of the tomb presented a clearly Egyptian character; during the second period, Greek influence predominated.

The masks and funeral statuettes found among the skeletons give us some idea as to the physiognomy of the ancient Carthaginians and their costume. One appears to represent a young man, whose hair, arranged upon the head in parallel curls, stops in the center of the forehead and falls in ringlets on each side of the neck. A wide, closely cropped beard surrounds the fall. The ears are provided with apertures for pendents. The fall is somewhat effeminate. Another, on the contrary, has a virile aspect. If we desire to know how one of the great counselors of Carthage looked, it will suffice to take a glance at the statue found lying upon a sarcophagus. It is a man with a curly beard and a venerable appearance. The head is surmounted by a turban, and the body is surrounded by a long robe that extends to the feet, and from whence escape the naked arms. A long great coat, or epitoga, fixed to the shoulder by a clasp, descends to the middle of the leg.

CARTHAGINIAN NECKLACE.



ELEMENTS OF A NECKLACE.

The portraits of the women are no less precise.

A SPHINX-SHAPE VESSEL.

At first sight, one might think that he had Egyptian females before the eyes. Their hair is generally fastened around the head by a band that covers the top of the forehead, and forms beneath a number of curls that fall at the two sides of the head in two masses of tresses which pass behind the ears and spread out upon the breast. The eye is almond-shaped and underlined with black, and the lips, as well as the ears and cheek bones, are painted a bright red. Like the Arabian women, the Carthaginian females bedecked themselves with ear-rings and bracelets, and especially with necklaces. The elements that composed these latter have been found in the ground, and so it is easy to get an idea of their variety and richness. In them, we find all kinds of metals, all kinds of stones, and various motives. Pastes of glass alternate with acorns of crystal, and medallions of gold with pieces of agate and carnelian. With motives of pure ornamentation were mingled those amulets so dear to oriental women. Among the rich, small cases of precious metal inclosed plates of gold or silver, upon which were engraved divine figures and formulas for prayers, and, among the poor, small shells or common scarabæi. To such a wealth of jewels must have corresponded a fine quality of fabrics and splendor of garments; but these are things that time does not usually respect. As far as can be judged from the statuettes, the women wore a long tunic that descended to the ground, and a girdle terminating in fringes was bound about the abdomen and fell over the thighs.

After this comes the pottery. Not hundreds, but thousands of terra cotta vessels have been taken from the necropolises. As a general thing, these are of crude manufacture, of red or gray material, sometimes with a yellowish coating. When they bear ornaments, the latter are rectilinear brown, red or black fillets drawn with a pencil before firing. The most common recall those large Greek or Roman amphoræ that were used in lieu of casks; but their neck is shorter and their form more squat. They do not exceed three feet in height. Certain of them are provided at the bottom with a long cylindrical appendage that was inserted in the ground in order to assure stability.

The pots, jugs and saucers scarcely differ from those

CARTHAGINIAN LAMP.

that have been employed in all ages. They exist in great variety. Quite a different type consists of a spherical belly terminating above in a circular neck, and provided in the center with a sort of nipple. As such vessels have been found only in the tombs of little children, it has been concluded that we must recognize in them the "nursing bottles" of the period. Sometimes the artists gave sway to their fancy, and the vessel became a dove, a winged sphinx with a human head, a horse loaded with amphoræ, or a monkey seated and holding between its legs a cylinder surmounted by a frog of which the gaping mouth served for the outflow of the liquid.

The Carthaginians, who displayed so much magnificence in certain table utensils and toilet articles, had nothing to afford them light but primitive lamps. Imagine a wide saucer with nearly flat edges pinched between three fingers so as to form upon one of the sides two small gutters for the wicks, and you have a Carthaginian lamp. These lamps have been compared to conches, and it has been thought that after using shells filled with oil for obtaining a light, the Carthaginian colonists took such objects as a model. However this may be, this method of lighting remained defective and inadequate.

Iron and bronze do not withstand time and humidity so well as gold, stones or pottery, and so the tombs have yielded us only rare specimens and these of less interest. But a single sword has been found, while mirrors are met with quite frequently. These were disks of bronze provided with a handle, and the surface of which was polished and covered with a coating of tin or silver. There have also been found a certain number of objects of peculiar form that were formerly regarded as hatchets, but are now regarded as razors.

After we have mentioned some small terra cotta tables and chairs that seem to have been playthings, we shall recall nearly everything that has been found of independent Carthage and its inhabitants. After making a reckoning, it must be confessed that we remain in pitiful ignorance. The victorious Romans took pleasure in effacing every remembrance of their terrible enemy, and succeeded only too well.—For the above particulars and the engravings, we are indebted to the Revue Universelle.

BATRACHIA AND REPTILIA.*

THE reptiles (snakes, lizards, crocodiles and turtles) are covered with scales, and the batrachia (toads, frogs and salamanders) are perfectly smooth-skinned, without any trace of scale-like surface. In reptiles the skull is joined to the vertebral column by one joint just below the spinal cord's entrance to the brain, and there is only one occipital condyle; in the batrachians the joint has two condyles, one on either side the aperture—wherein the mammals agree with the batrachians, the birds with the reptiles.

All of the batrachians present a marked departure from the structure of fishes, being adapted for life on land at least through part of their lives, and therefore having regularly developed feet, instead of fins as in the fish. While in some of the fish the fins may be used to crawl out on the edges of the streams (some species being able to live out of water quite a little time), yet in none is there any approach to limbs such as we find in the batrachians.

The structure of the salamander does not change so remarkably as that (so well known) of the toad. When the salamander is hatched it looks very much as in adult life except that it has no well developed gills on the side of the neck and does not breathe by lungs. In some few cases the salamanders always remain aquatic and never acquire lungs; the gills are persistent and remain throughout life. There is one quite interesting species, called by the Mexicans the axolotl, found in the lakes about the city of Mexico in a very arid, desert region; and if these salamanders crawled out on the dry, sandy ground, they would in all probability be killed by the hot rays of the sun. They do not find any moisture or rank vegetation in which to conceal themselves; therefore, they pass their whole life in the larval stage, with well developed gills. For a long time it was supposed the axolotl was never able to develop beyond this larval stage; but some of them were transported from their original Mexican homes and kept in an aquarium, and it was found after two years of such life, when suitable conditions were presented and they could crawl out of the water, they did so, developed lungs, and became regular adult salamanders—a case of evolution to meet environment.

In the larval batrachia (the young salamanders and the tadpoles) the gills are very different in structure from those found in the fishes, which have a remarkable bony arch developed on each side of the neck, each one serving as a support for the gills; while the batrachians have simply fleshy protuberances and no essential structure corresponding to the gill arches of fishes—entirely lacking the operculum which covers the side of the fish's head and protects the gills.

The batrachians comprise a number of groups, the vast majority being found in the tropics and comparatively few in the temperate regions. The lowest group includes the species proteus; another, the sirene. These two animals are very much like some of our ordinary salamanders; but they are almost entirely aquatic and (like the axolotl of Mexico, which is really a larval salamander), they have gills throughout life, never developing beyond this state; they are not really a very low type, but seemingly degenerates from a higher group, their legs having become abortive and the hinder part of the sirene entirely lost. The third group includes the salamanders; the fourth, the frogs and toads. The caecilians are a curious group of batrachians which are sometimes placed in a different order, but which the late Prof. Cope considered very degenerated salamanders, into which fall the proteus and the sirene. Some of the species of proteus occur in Cimmerian caves in various parts of Europe, their eyes having become very small and entirely covered over by the coatings of the skin and of course functionless. In America we have one or two species of both proteus and sirene, found mainly in the ditches and streams of our South Atlantic and Gulf States; about the Great Lakes, but none in the Middle or New England States.

Of the salamanders there is a vast number of species; but with the exception of a few found in Europe and Mexico they are almost entirely limited to North America north of Mexico. A specimen of the giant salamander of Japan (the largest batrachian known) girthed eight to ten inches and was a yard long. It has a close ally in the peculiar salamander known as the hellbender (about the length of the tail of the giant salamander) found in the tributaries of the Mississippi, in the Ohio and Allegheny Rivers, and a few in the Susquehanna.

The caecilians look exactly like huge earth-worms,

* Abstract of lecture delivered at the Academy of Natural Sciences of Philadelphia. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

some of them being two feet in length and having little rings or creases in the skin like the earth-worms; but they have a mouth at one end, and careful examination shows traces of eyes. They have all their organs rudimentary and are entirely subterranean—an important species abundant in South America burying in the soft earth which has been perforated by the homes of the white ants and there making their abode.

A very remarkable deviation from the general structure of the salamander is shown in the frogs and toads, which have entirely lost their tails and developed hind legs enormous in proportion to the length of the foreleg. The frogs are always more or less aquatic, as are the toads in the tadpole stage; but the adult toads are entirely terrestrial, except during a short period in the spring at the breeding season when they take to the water like the frogs, remain there until the eggs are deposited, then come forth and occupy the land until next spring. There are some eight hundred known species of frogs and toads, found mostly in the tropics and sub-tropics and comparatively few in the north temperate regions.

Birds and mammals have well developed voices; some of the reptiles give a peculiar hissing sound; but the frogs and toads are the lowest animal type having a well developed voice. The tongue of the frogs and toads is always attached at its front, instead of the back end as in birds and mammals, and is used to capture their insect prey by throwing it out and drawing it back into the back part of the throat. Some species of the frog, however, have no traces of tongue at all.

One of the lowest American species of toads has a bag upon its back in which the eggs are placed, as in a knapsack, carried about and hatched. In the case of the Surinam toad (a large species) the eggs are deposited by the female and by the male placed one by one on the female's back; the whole skin then swells out and surrounds these eggs, each one resting in a little pit; and thus she carries them around, and the young toads eventually hatch out and swim off into the water. After they are all off the female subsides to its former size. In another species the male sticks all the eggs on the sides of his legs, and the coating of the egg being quite sticky and glue-like, the eggs remain there until the young hatch and swim off in the same way as the others from the female's back.

Snakes are practically lizards which have lost their limbs, and progress entirely by an undulatory motion over the open ground. The snakes and lizards usually appear quite different; however, a large series of these animals from the tropics exhibits a gradation from snake to lizard so perfect that it seems almost impossible to draw the line. Some of the lizards have entirely lost their legs but have a perfectly developed and narrow neck; certain others, well developed legs and saurine heads, yet whose lack of certain features would place them more nearly with the snakes.

Going back in geological time we find innumerable remains of reptiles vastly different from anything extant and exhibiting a much greater diversity than present-day forms. Certain of the most important reptilian groups that ever existed have become entirely extinct. Besides the well-known snakes, lizards, turtles and crocodiles, the geological forms embrace a large number of reptiles known as ichthyosaurs—aquatic reptiles taking somewhat the place whales now do among mammals; other groups of reptiles, large as elephants, allied to the hydrosaurs, and still another group known as the pterodactyls—reptiles which flew about in the air and occupied in the reptilian series the same position as do bats among mammals.

The birds have developed from such stock as these flying pterodactyl reptiles: all the pterodactyls had well developed teeth, as had our earliest fossil birds; while in the living birds the teeth were lost, and the jaws covered with a horny beak. From some of the larger terrestrial reptiles the mammals have developed. Just why groups of reptiles allied to the hydrosaurs, and the bird-like reptiles (the pterodactyls) were completely exterminated and succeeded comparatively suddenly by such groups as the birds and mammals, there is no satisfactory evidence; but we certainly know that at one time the earth was inhabited by large numbers of these peculiar forms and to-day they have been almost entirely exterminated. Our fossil groups of reptiles not known at all are as many as the groups still extant.

The groups of reptiles found to-day are four: snakes, lizards, turtles, and crocodiles.

Snakes, as has been said, are practically lizards which have lost their limbs, in lieu whereof the scales which covered the ventral surface have become greatly enlarged and reach clear across that surface from side to side; and by successively elevating these scales the snake is enabled easily to progress over the ground: the scales are partially released and help the animal to move along by an undulatory motion. The snakes are divisible into several quite different groups: first of all, one restricted mainly to tropical countries, more or less blind and usually subterranean in habit, or else living under logs and such covering; they are small, and apart from their peculiar degenerate condition present no remarkable characters. Then come two groups of poisonous snakes numbering comparatively few species; while the fourth group (the colubrine snakes), includes all the other species—probably nine-tenths of all snakes known. The first group mentioned is characterized by a little snake known as the typhlox. In the large colubrine group are almost all our garter-snakes—common snakes—and the boa-constrictor—all the best-known of the non-poisonous snakes.

The first group of poisonous snakes includes the well known cobra; the other poisonous group, the rattlesnake and its allies; in all, the poison is administered by certain of the teeth known as fangs. In the cobra and its allies (including the little coral snake of our Southern States), there is no regularly developed poison bag: over one of the posterior teeth through a little groove in the side the poison runs down; and of course these snakes (the smaller species especially) are less dangerous, because they have got to get a very firm grip on the victim in order to strike that tooth firmly into them. The mouth has to be entirely open and the tooth in the back thereof must strike the victim.

In the rattlesnake, the copperhead, and water-moccasin of the South, we find a different development: the poison gland is forward, and there are very highly developed poison fangs, hollowed and very sharp-pointed on the end, which project in the forward part of the mouth. These fangs are laid back when at rest; but when the animal strikes they are thrown up in a vertical position and driven straight into the victim.

Among the lizards, the geckos (one group) have the peculiar sucking disks on their toes enabling them to walk up vertical walls; the group of iguanas includes a great number of our smaller American lizards—the largest iguanas being four or five feet long and found in all tropical countries, being especially abundant in Central and South America; while another group contains only one species—the peculiar Gila monster of Arizona—a very sluggish reptile, exceedingly difficult to provoke to the biting point, yet whose saliva experiments prove to be poisonous, it being the only known poisonous lizard.

There is another and very peculiar group of lizards (inhabitants of Africa) known as the chameleons, which are more different from any other group than from each other. They are all entirely arboreal. Their four toes, instead of being arranged three together and one behind, or all four pointing in the same direction, are exactly divided in twos; so that there are two pairs—two toes on each side; and the foot is brought together in such a way in clasping the branches that it gets exactly the same grip on each side, making a most perfect foot for prehension. Another peculiar structural feature is their power of moving the two eyes independently. In almost all animals the two eyes move and focus together on the object viewed; but with the chameleon it is quite possible to turn one eye in front and the other back; so that people looking over its shoulder will seldom find the eyes looking the same way, and they thus have a perpetually cross-eyed appearance.

The turtles present a development exactly parallel to the birds: the teeth are lost and the mandibles covered with a horny beak. In the green and the leather-back turtles (both almost exclusively aquatic), the feet are transformed into flippers or fins. The leather-back is one of the largest species known, sometimes growing to the length of six and one-half feet and weighing over one thousand pounds. Professor Cope, speaking of this turtle, said that when he first saw it, it had been caught by the fishermen and was placed in a small room of an oyster shop; the back portion of the shop had been separated from the front by a light partition; the turtle was supposed to be practically dead. The man was sitting there on an ordinary chair, contemplating it, when all of a sudden the turtle threw out its front flippers and not only knocked the chair out from under the man, but entirely through the partition—showing the enormous power of these animals.

The land turtles reach their highest development in the Galapagos Islands, where they are fully three feet long and two and one-half to three feet high, and there are similar turtles in some of the islands on the east coast of Africa. Their immense development is probably due to the higher mammals' never having reached these islands, which were probably separated from the mainland or else brought up by volcanic or coral action; and the turtles have become introduced to the islands after formation, or been washed over by floating trees, and have developed there entirely unmolested by the higher mammals or forms which would prey upon them, and thus have acquired these enormous dimensions. During the last few years the Honorable Walter Rothschild, of London, has been interested in making a study of these large turtles and sent out an expedition to the Galapagos, bringing back several hundred. If they are to be exterminated (as is likely from increasing visitation and immigration to these islands), it is probable that it had better be done in the interests of science than by gradual extinction, although Mr. Rothschild's magnificent series has not entirely removed them.

The fourth group includes the crocodiles and alligators, the main point of difference between them being that the canine teeth of the crocodiles fit into notches in the upper jaw and the teeth of the alligators into pits. In some of these crocodiles the longer teeth in the front of the lower jaw have pushed their way entirely through the upper jaw, a specimen of which, from Florida, may be seen in our museum.

We have only one species of common toad in this vicinity, but another animal bearing some resemblance to the toad known as the hermit spadefoot—a rare species having a peculiar shrill cry, different from that of the toads. Among the smaller toads generally known as tree-toads (all more or less arboreal) we have several species—two little green ones: the cricket frog and the Pickwick frog, each occurring in streams in the spring during the breeding season and very noisy, theirs being one of the first sounds of the spring in the woods and dells; also one other, larger species known as the gray tree frog. After the breeding season in the spring the young and the matured frog become entirely arboreal and climb up on the trees.

Among the sub-divisions of the snakes we have representatives only of the colubrine snakes and the rattlesnake group. Of the commoner snakes there are the little greenish-black, spotted garter-snake—probably the commonest, best known form; the large brownish species—the water-snake, more or less aquatic; the milk snake and the hog-nose snake, which is a very vicious form, partaking much of the action of the rattlesnake, although harmless. The hog-nose snake has the front of the nose elevated into a little hard point or beak somewhat resembling the snout of a hog—whence its name. Of the poisonous snakes we have only the rattlesnake and the copperhead, both becoming scarcer every year. The snakes all suffer a great deal in this respect: there is a tradition that a snake ought to be killed as soon as it is seen. As a matter of fact, the majority of snakes are quite harmless and do much good in the killing of mice and other injurious animals.

The habit of snakes in swallowing their food is very interesting. The bones of the neck are very loosely jointed together so that they are capable of being stretched widely apart, enabling the snake to swallow an animal very much larger, apparently, than its own diameter. Some of the snakes are particularly voracious and fierce. We have in this group a little, blackish snake found in New Jersey, generally known as the king snake—glossy black, with narrow white lines all over the body in a sort of chainlike pattern from end to end. It develops to two or three feet long. One of these specimens was kept alive here at the Academy one summer together with an example of the ordinary water-snake (the same size as the king snake), and also a very fine specimen of the pine snake (which acquires a length of fully four feet) found in the New Jersey pine barrens. The pine snake was about four feet long; the other two about two and one-half feet: all confined in one box; but after a day's absence the gentleman in charge coming back and examining them found that the water-snake had disappeared; the king snake was suspiciously fat and found to have swallowed the entire water-snake. Some days after that the largest of the group (the pine snake) was taken out and chloroformed. The snake was supposed to be dead and the plaster was laid over it and a cast made; but when it was removed from the plaster it showed signs of life and, being left out in the air, soon recovered partially and was put back in the box; but an hour or two after that, on going to the box, I found that the small king snake had started to swallow this large pine snake that was still suffering somewhat from the effects of the chloroform. He stretched his mouth open to the widest extent and, beginning at the head of the pine snake, had swallowed as much as he could get down; he had already gotten to the largest diameter of the pine snake, so that he could not swallow any further; his mouth was stretched to its widest extent; and on removing the pine snake, it subsequently recovered, not having been in the other snake sufficiently long to be digested; but after killing the snake, I found it had swallowed another species; so that of all the snakes this little king snake is the most voracious.

RUBBER CULTURE IN VENEZUELA.

CONSUL GOLDSCHMIDT transmits from La Guayra, November 1, 1901, an article published in the Venezuelan Herald, which the consul notes is of unusual interest to all who wish to study the cultivation and exploiting of rubber, on account of its details and apparent knowledge of a subject generally very little known. The article reads:

THE CAOUTCHOUC OF THE UPPER ORINOCO.

By DR. LUCIEN MORISSE.

In the course of the explorations which I made in the years 1888 and 1889 on the Orinoco and in the district of the Rio Negro, I was obliged to execute much medical and botanical work in order to carry out the missions with which I had been honored by the Minister of Public Instruction and Fine Arts. These circumstances led me to make a profound and complete study of one of the botanical essences found most extensively in those regions, which are of the richest and most interesting for science and industry. I refer to caoutchouc.

That of the Orinoco, known as Ciudad Bolivar caoutchouc, on account of that city being the principal market for the product, is exactly the same as that found on the Amazon, and known as Para caoutchouc; it is extracted from the same tree and the crop is reaped in an analogous manner.

The various classes of caoutchouc found in these regions are of the species *Heveas*, which belong to the great family of the *Euphorbiaceas;* the caoutchouc of the Orinoco is therefore the true *Syringa brazilensis*. Nevertheless, there are various kinds of *Heveas*, of which I have found four varieties on the Orinoco, and I have noted that all the trees grow near together and give a like gum.

The product of the caoutchouc is everywhere the same—the Para—except, perhaps, that of Guayana, which, when the sheet is fresh, is of a bluish white; when, however, it is dry, it is impossible to distinguish it from the pure Para.

These species are very different from that which comes from Africa, especially Madagascar, which is generally the product of *Ficus elasticus* (a fig and not a *Hevea*) and are superior to them, Para caoutchouc being most highly esteemed and the dearest, on account of its several qualities.

Ficus elasticus is found on the Amazon and the Orinoco, and produces a milk; but naturally in the regions where the *Heveas* are so numerous and productive, that species is not exploited. It is curious to remark that while the *Hevea* is called *Syringa* in Brazil, it is called caoutchouc in Venezuela, where the *Syringa* is called the *Ficus*. All these various caoutchoucs, known as Para, generally reach the markets of Europe in the form of large loaves of first, second, and third quality, and the residue in the shape of balls.

I shall not dwell on the distinctive characteristics of the *Heveas*, which are generally well described in all botanical treatises; but shall limit myself to making a few observations on its physiology and other peculiarities which enable the Indians to recognize it at a glance.

The sap of the *Hevea* is a milk found in the bark of the tree, which ascends and descends naturally like all sap, according to the season of the year, and advantage is taken of this law to gather it by means of incisions made in the trunk, the product from which is more abundant as the incisions approach the dermis. The *Hevea*, when cut or tapped, ratoons from the foot, and these ratoons at the end of five years yield a product equal to that of the original tree.

APPEARANCE OF THE HEVEA.

This tree grows rapidly, upright and smooth, to the height of 30 or 45 feet, and even more. The branches spread out and lift themselves up on every side, causing the top to have a spheroidal shape. The leaves

are trilobular, arranged one in the middle of the stem and two at the sides. The *Hevea* is the only tree which I have seen in these regions which has the peculiarity of terminating in a trefoil. Owing to this, the Indians never make a mistake, and recognize the *Hevea* among a thousand trees without pricking it.

The Venezuelan government forbids the natives to fell these trees; but this prohibition is altogether unnecessary, as it relates to an immense forest, measuring upward of 30,000,000 hectares (74,000,000 acres) where caoutchouc exists in abundance, and which it would require millions and millions of hands to exploit, whereas it only contains three or four thousand Indians, not more than the tenth part of whom are engaged in the work. Fifty thousand immigrants might well be introduced for the purpose of cutting the largest number of trees possible without the least fear of destroying the forests, and the work carried on in this fashion would, in my opinion, be more efficacious and productive.

The Colombian government, on the contrary, permits the trees in its territory to be felled, and this is done to a great extent on the Guariare and on the Cañon San Martin.

In Venezuela, the Indians are restricted to pricking the tree, and they work and prepare the gum in the following manner:

The Indians make a track or pathway with their cutlass, which serves them to cut away the branches and reeds, and, in a word, to open up the forest. For convenience in moving from one location to another, the Indians travel about in canoes, and for that reason they have no cause to penetrate into the forests, and much less to make perpendicular tracks to go to the river; but having established themselves on the margin, they work in tracks parallel to the river, which enables them to reach by water any part of the track on which they may be working. This practice should be forbidden, if it is desired to exploit in an orderly and a complete manner. The tracks should all start from one point and go off into the forest in every direction like a fan, in order to obtain an exact knowledge of the forest.

PREPARATION OF THE HEVEAS.

As soon as the trees have been recognized and selected, the Indian scrapes them lightly with his knife in order to free them of the moss and other roughnesses and inequalities of the epidermis, so that the milk may trickle over a surface as smooth and clean as possible.

It is at this stage that the product is adulterated. Among the milk-yielding trees, which are so numerous in these forests, there are a great variety which produce gum. Up to to-day, I have recognized six species—the pindare, etc.—which, for the most part, are nothing but balata; these are gums which contain from 30 to 50 per cent resin, which renders them unfit for the industry. I have discovered a very simple, almost mechanical, process for isolating these resins in the fresh milk, and have obtained almost, if not quite, pure gutta-percha. It is superfluous to add that the only method of utilizing them known to the Indians is to adulterate the true caoutchouc therewith.

While the *Hevea* should be pricked and prepared carefully, so that the milk should run slowly, at the rate of 100 to 150 grammes maximum per tree, the contrary happens with the milk of the pindare; for example, the juice is contained to a greater extent in this tree, and pours forth in great abundance if only one incision has been made, thus yielding from 250 to 300 grammes in a quarter of an hour. This product is coagulated by means of smoke, just as the caoutchouc. The Indians therefore mix the milk of the two varieties in the following manner: They place them in different vessels near the oven and coagulate them in alternate layers in the trough.

If the sheets contain only pindare, they will be known at first sight by their hardness, their inclination to soften, and want of elasticity, which is proved by their retaining the marks left by pressing the finger on them; while the adulterated article, when it has been covered over with a cap of pure caoutchouc, has the aspect and color of the genuine article.

MODE OF DETECTING THE FRAUD.

If the sheet of adulterated gum is thrown on the ground, it does not rebound like a ball of pure caoutchouc, but on falling produces a dead sound and remains immovable as a log of wood. Further, if the sheet is cut through, the layers of the first species differ from those of the second in being denser and harder and in retaining the impression of the finger on being compressed.

NECESSITY OF SMOKING THE GUM.

The system of applying smoke to the milk, or something to produce the same effect, is indispensable. In however cleanly a way caoutchouc may be worked up it would be impossible to obtain perfect cleanliness, or to prevent the formation of little air globules, which would nullify the heat received by the sheet while it was being revolved in the hands of the workman over the oven, this heat being at the same time the beginning of the process of coagulation. Nevertheless, it unfortunately happens that some globules remain inclosed, which cause the paste to rise up almost imperceptibly and bring about decomposition by fomenting. Caoutchouc which has not been smoked is less valuable —as, for example, that from Madagascar, which is white when brought to market; perhaps if it were smoked it would be as valuable as that of Para. In Colombia, caoutchouc is also the product of the *Hevea*, but it is coagulated by the heat of the sun and is worth one-third or one-fourth as much.

TOPOGRAPHY.

On the Upper Orinoco, the caoutchouc trees begin to be found in considerable numbers only below the Falls of Maipure; on the affluents of that river, to the west of the Meta, Meseta, Tomo, Chuparo, Vicheda, the Atabapo, and to the right of the Catanopo, no appreciable number is found. The Venezuelan Guayana or Black River contains a number of species as far as Maroa; from that point they gradually become rarer, but they again abound below San Carlos, and from there on they are found at varying distances all along the Rio Negro up to its confluence with the Amazon.

ABUNDANCE OF HEVEA IN THE FORESTS.

The *Hevea* are disseminated through the forests at varying intervals, which on the Orinoco average 25 meters (82 feet), more or less. On the Casiquiare trees are to be found at every 10 or 12 meters, and on its affluents, the Pacimone and the Siapa, they are so abundant that they nearly touch each other. On the Rio Negro, from the mouth of the Casiquiare to the Cocui, they are found at a distance of 15 meters, more or less; in Marivitana, a little farther apart, and they almost disappear toward Taparucuara, to reappear again a little lower down at San Gabriel, on the Amazon; from Mancos to Para, they are not more clustered than at Pacimone and Siapa.

RICHNESS OF THE HEVEA.

On the Orinoco, each tree produces 40 to 50 grammes of milk; on the Rio Negro, from 80 to 100; on the Casiquiare, from 125 to 150. The yield in gum is in proportion to the density of the trees in the forests. It would further appear that the ascent and descent of the sap does not take place at the same time in all the trees of the same forest.

There are many which have a splendid appearance and yet remain unproductive for years, or the yield from which is so small and of such bad quality that it can not reach the reed conductor employed by the Indians.

Certain small and apparently insignificant trees, with delicate branches, yield abundantly after having remained unproductive for years; others which ought to have produced long since, covered with cicatrices and scars produced by former milkings, give no result, as is also the case with some which have magnificent foliage.

The causes of these phenomena are incomprehensible; and it would require prolonged observation and study in order to arrive at a perfect knowledge of the pathology and physiology of the *Hevea*. What is certain is that the sap is very capricious, and it is very difficult to say to what law it is subject.

THE HATCHET OF THE INDIANS.

The Indians make an incision into the tree with a hatchet not larger than the thumb, an end of which is affixed to a wooden handle a foot long; the blade is 1½ centimeters wide. The instrument is applied obliquely to the bark of the tree and struck on the back with a piece of wood, thus making it penetrate into the bark and produce the incision. The Indians generally make four oblique incisions on a vertical line on the same tree; sometimes more and sometimes less, and at various heights, but so that the milk from one line of cuts should pass over the lower incision. This proceeding is very useful; for, if the first drops which issue stick to the tree and are lost, these cuts serve to conduct the later drops which course with greater rapidity to the reed and afterward to the deposit.

RESULTS OF EXPERIMENTS IN THE WORK.

Let us transport ourselves to the territory of the Casiquiare and take it for granted that every tree produces 100 grammes of milk, not basing our calculation on the labor of the Indians, because their indolence and laziness render it impossible to base any calculations on the product obtained, but on my own work, as a European day laborer. During fifteen days, I pricked 114 trees per hour, and as I employed eight hours daily, I prepared 912 trees daily, during which time the enormous quantity of 80 kilogrammes (176 pounds) of milk coagulated.

The sheet of gum, by drying, loses 35 per cent of its original weight; by making cernamby (the preparation which is obtained from the residues of the principal substance), and working eight hours, as above said, I have daily produced 50 kilogrammes (110 pounds) of fine and dry caoutchouc. My caoutchouc sold, at the period of which I am writing, at 7 francs per kilogramme ($1.35 per 2.2046 pounds) and gave a net clearance daily of 750 francs ($144.75). Owing to the Brazilian revolution, Para caoutchouc is at present worth 10 francs ($1.93) per kilogramme, and will reach 14 to 15 francs ($2.70 to $2.89). At the present price, I would have gained 500 francs ($96.50) daily.

These figures appear exaggerated, and I should not have ventured to have set them out here if I had not done the work so scrupulously.

A man, an emigrant, who wishes to work can, by laboring six hours a day, view 1,000 trees and prick 500 daily, at the rate of 250 in the morning and a like number in the afternoon, and at the same time prepare 250 grammes of caoutchouc. Before beginning the work he must spend eight hours in the forest to install himself, recognize the trees, and mark out his picas or tracks. Five minutes are sufficient to fix the reed and clay to a tree, and as (on the Casiquaire) they are at a distance of 15 meters apart, the workman in a day will have covered 7 to 8 kilometers (4.3 to 4.9 miles).

THE USE OF INSECTS AS FOOD.

M. DAGIN, a French entomologist, has recently written an article in which he recommends certain insects as an article of diet. He speaks with authority, having not only read through the whole literature of insect-eating, but having himself tasted several hundreds of species raw, boiled, fried, broiled, roasted, and hashed. He has even eaten spiders, but does not recommend them. Cockroaches, however, he says, form a most delicious soup. Pounded in a mortar, put through a sieve, and poured into water or beef stock, Dagin says they make a purée preferable to bisque. Wilfred de Fonvielle, the French scientist, prefers cockroaches in the larval state. The perfect insect may be shelled and eaten like a shrimp. Then, caterpillars are a light food and easy of digestion; not only African and American natives like them, but they are also appreciated by Frenchmen. M. de Lalande, the astronomer, dined every Sunday with the zoologist Quatremere d'Isjonvalle, and Mme. d'Isjonvalle used to collect caterpillars and serve them to the guest. The locust is much eaten by the Bedouins, and may be enjoyed fried, dried in the sun, ground into flour, boiled in milk, or fried and served with rice. The Jesuit father Cambon thinks that locust flour might become popular in Europe as a condiment. The precise opinions which are expressed by travelers as to locusts differ considerably. Amicis said that they taste like shrimps; Niebuhr, like sardines; and Livingstone, like caviare —another illustration of the differences of palatal appreciation.—Medical Times and Hospital Gazette.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Packing for Asia Minor.—The question of transportation from the coast to the inland cities of Asia Minor is of prime importance in connection with all efforts to establish trade relations at these points, especially at such centers as Harput and Diarbekr, far removed from the seaboard. A wagon road extends from Samsoun, on the Black Sea, to both these points, and vehicles make the journey in a little over a fortnight. The bulk of the traffic, however, from Samsoun, as well as all the transportation from the slightly nearer port of Alexandretta, on the Mediterranean, is by means of camels, horses and mules. Out of 12,000 loads of merchandise received annually at Harput and Mezreh, but 150 are wagonloads.

In order to insure the lowest possible freight rates, it is essential for foreign exporters to adapt the size and weight of their packages as far as practicable, to the local requirements. The following information and suggestions may be helpful to those who are endeavoring to gain a foothold for their wares in central and Eastern Turkey.

This is available for freight forwarded to the seaport of Samsoun. It is the only means of transport, and the route the only means of communication available for packages exceeding 240 pounds (85 okes) in weight. Wagoners are unwilling to take packages exceeding 510 pounds (180 okes). Such packages, as well as light packages of large or awkward volume, pay excess freight. The maximum weight of a package which can be transported by wagon is 1,415 pounds (500 okes).

In packing for this market, boxes or bales which are to be forwarded by wheeled transportation, care should be taken to have the cases and wrappings of a thoroughly solid and substantial nature, and to pack the contents so tightly that there is not the slightest possibility of friction. These precautions are of prime importance, in view of the journey of fifteen to twenty days in springless, jarring vehicles over highways originally well constructed, but now in a sadly dilapidated condition. Samsoun agents protect packages, when necessary, with coarse, waterproof coverings before forwarding to the interior.

As an instructive example of freight charges on goods from abroad, I might quote the following data on a recent consignment of American agricultural implements to Harput: The lot included 1 mower, 3 plows, 3 cultivators, 1 harrow, 40 rakes, hoes and forks, 2 sets of harness, etc. Gross weight, 2,839 pounds; net weight, 1,999 pounds; cubic feet, 136.8. The freight rate from New York to Samsoun was $14.67, plus $1.80 insurance and $2 cartage in New York. The freight charge from Samsoun to Harput was $55, the rate being slightly higher than usual on account of the presence of two very bulky cases.

The necessity for very compact and tight packing is less imperative than by the preceding method; the range of weight is, however, much more restricted. The normal weight for a package to be carried by the average horse or mule is 177 pounds (62½ okes). Muleteers dislike to take heavier loads, but occasionally accept packages weighing up to 198 pounds (70 okes). For packages less than the normal weight, simple fractions, such as the half or third of the above figure —177 pounds—can be adjusted most advantageously to the pack animal. The preferable shape of a package is oblong, the proportions approximating those of a customary dress-suit case.

The above remarks, concerning shape, division of weight, manner of packing, etc., apply also to transportation by camels. This method is the least expeditious, but on the other hand the cheapest and the most satisfactory of all the means of freighting. The slow, deliberate tread of the camel causes a minimum of jarring to the contents of the boxes. The preferable weight of packages for camels is 226 pounds (80 okes); the maximum weight is 246 pounds (85 okes).

Freight rates from Samsoun to Harput, a distance of 307½ miles (495 kilometers), vary from $1.40 to $1.97 per 100 pounds ($31.36 to $43 per ton of 2,240 pounds, or $3.09 to $4.34 per metric quintal of 100 kilogrammes), or 10 1-5 to 14 cents a mile per ton of 2,240 pounds. Camel transport is the cheapest form of transportation; freight wagon the dearest. The latter method is most expensive in winter and early spring, when mud is deep and the mountain passes are obstructed by snow. Transport by pack animals is cheapest in the spring and early summer, when herbage is abundant by the wayside and the cost of subsistence en route sinks to the vanishing point.

Needless to say, all commercial interests in this region long for the realization of some one of the various projected routes of railway, bringing Harput and Diarbekr into steam communication with the seaboard. The time-honored caravan route from Bagdad to the Black Sea, upon which Harput is the half-way station, will then cease to be more than a historical reminiscence.—Thomas H. Norton, Consul at Harput.

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TRADE NOTES AND RECEIPTS.

To Prevent the Freezing of Water Pipes.—Cover the pipes with sawdust and a layer of short straw, tanning bark or similar material and lay on top of this pieces of burnt lime of the size of a nut or a fist, which in turn are covered with a layer of short straw. Then the ditch is filled up in the case of pipe conduits near the surface. The lime very gradually attracts moisture, and the evolving heat suffices to protect the pipes from freezing during the entire winter. If the pipes are already frozen they may be thawed out by covering them, as described above, with litter and burnt lime and then pouring on water.—Praktischer Wegweiser.

Parisian Cement After Sorel.—Mix 1 part of finely ground glass powder, obtained by levigation, with 3 parts of finely powdered zinc oxide rendered perfectly free from carbonic acid by calcination. Besides, prepare a solution of 1 part, by weight, of borax in a very small quantity of hot water and mix this with 50 parts of a highly concentrated zinc chloride solution of 1.5 to 1.6 specific gravity. As is well known, the mixture of this powder with the liquid into a soft, uniform paste is only accomplished immediately before use. The induration to a mass of the hardness of stone takes place within a few minutes, the admixture of borax retarding the solidification somewhat. The pure white color of the powder may be tinted with ocher, manganese, etc., according to the shade desired.

Light Without Danger of Fire.—The necessity frequently arises to use a light in storerooms, etc., where there are combustibles stored. By the following way a cheap and safe source of illumination may be had. Take a long bottle of pale glass and put in a piece of phosphorus the size of a pea; upon this pour pure olive oil heated to the boiling point, filling up the bottle about one-third, and cork up tightly. When light is needed remove the cork and allow air to enter, subsequently recorking the bottle. The whole empty space in the bottle will now become luminous, the light being most effective. If the luminosity should diminish, it may quickly be restored by opening the bottle and allowing fresh air to enter. In very cold weather it is sometimes necessary to warm the bottle in the hand to render the oil more liquid. One bottle lasts all winter. This remarkable lighting agent may be carried in the pocket.—Deutsche Goldschmiede Zeitung.

Preparation of Chartreuse.—Like the famous Bénedictine liqueur, Chartreuse has been prepared for centuries by monks in a French convent (Grande Chartreuse). While formerly the manufacture was a rather primitive one, the factory rooms of the said cloister are to-day equipped in the most magnificent and astonishing manner. In immense cellars the alcohol barrels which contain up to 5,000 liters are stored, and in the reserve magazine millions of bottles are awaiting shipment to all parts of the world. The annual sale is said to amount to more than 4,500,000 bottles and is still increasing.

Following are some good recipes for the preparation of a very excellent Chartreuse liqueur:

Elixir végétal de la Grande Chartreuse.

Fresh balm mint herbs	640
Fresh hyssop herbs	640
Angelica herbs and root, fresh, together	320
Cinnamon	160
Saffron	40
Mace	40

Subject the above ingredients to maceration for a week with alcohol (96 per cent) 10,000, then squeeze off and distill the liquid obtained over a certain quantity of fresh herbs of balm and hyssop. After 1,250 of sugar has been added to the resultant liqueur, filter.

The genuine Chartreuse is known to come in three different colors, viz., green, white and yellow. The coloration, however, is not artificial, but is determined by the addition of varying quantities of fresh herbs in the distillation. But since it would require long and tedious trials to produce the right color in a small manufacture, the yellow shade is best imparted by a little tincture of saffron and the green one by the addition of a few drops of indigo solution.

Another recommendable receipt for Chartreuse is the following:

Balm essence	2
Hyssop essence	2
Angelica essence	10
English peppermint essence	20
Nutmeg essence	2
Clove essence	2
Alcohol (80 per cent)	2 liters
Sugar, q. s.	

It is obvious that it is not easy, even when using good recipes, to perfectly imitate the superior flavor of the genuine liqueur, when it is considered that the great and exclusive secret lies in the use of perfectly fresh herbs. These plants all contain an essential oil, and vary in the percentage of the latter according to the soil in which they are grown. In the opinion of the Chartreuse monks the wild plants growing in the vicinity of their cloister are better adapted than any others for the preparation of the famous liqueur. When it is asserted that the friars are using a secret perfume which imparts to their liqueur the fine flavor and full taste, this is certainly an error, at least as far as the genuine liqueur is concerned. By the careful observation of the operations stated in the above recipes a liqueur is obtained, without the use of flavor correctives, which closely resembles in fineness the Grande Chartreuse liqueur.—Condensed from Neue Drogisten Zeitung.

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